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The Relation of Retention to Speed of Learning

by

HENRY LESTER SMITH

and

MERRILL THOMAS EATON

Bureau of Coöperative Research, Indiana University
School of Education
HENRY LESTER SMITH, Director
MERRILL T. EATON, Assistant Director

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The Relation of Retention to Speed of Learning

HENRY LESTER SMITH and MERRILL THOMAS EATON

INTRODUCTION

THE purpose of this investigation is to determine by exact, objective methods the relation of retention to speed of learning. No systematic attempt has been made, so far as the experimenters are aware, to investigate thoroughly several aspects of the problem with the same group of subjects. This investigation proposes to study the relation of retention to speed of learning for three different degrees of learning: (1) partial learning, (2) complete learning, and (3) overlearning. For each degree of learning the relation of retention to speed of learning is studied in six different types of learning materials: (1) nonsense syllables, (2) words, (3) names and dates, (4) geometric figures, (5) symbols, and (6) poetry. For each type of learning material, retention is tested seven times, the memory tests being distributed over time intervals of various lengths. Retention is measured by both the efficiency of recall and the speed of relearning.

Educationally, the extent of the relation of retention to speed of learning is a problem of paramount importance. Methods of teaching, organization of curricula, and, in fact, all educational procedures should be based on the way pupils learn and remember. If slow learners are fast forgetters, the value of pupil retardation is questionable. If, however, slow learners are slow forgetters, pupil retardation may be justified. Pupil acceleration, double promotions, and grade skipping may be justified from the purely learning aspects of education, at least, if rapid learners are also superior in efficiency of recall. On the other hand, if it is found that retention is not a function of speed of learning, and is not even closely related in a positive way, then opportunity rooms, special sections, and other devices for facilitating the progress of the slow learners may be justified.

Studies in the Field. Many investigations have been made of the relation of retention to speed of learning. Nevertheless, there seems to be inadequate proof for the old saying "easy come, easy go." A perusal of experiments will reveal, however, that there is far from complete agreement among authors as to the relation of retention to speed of learning.

One of the first studies making any reference to the problem of the relation of retention to speed of learning was by Ebbinghaus (21)[1] in 1885. Using himself as the subject, he learned nonsense and meaningful material by reading and then reciting until he had mastered it. He found that both meaning and speed of reading favored quick learning and tenacity.

[1] Numbers refer to references listed in the bibliography, page 101.

From 1887 to 1892 inclusive, Müller and Schumann (21) conducted an experiment in which nonsense syllables were read from a revolving drum and memorized. Retention was tested by the time taken to relearn material after 24 hours. The fast learner relearned most quickly. When the amount relearned and the original learning were compared, however, the slow learner was found to save more time "relatively and absolutely."

Whitehead (41) in 1896 used nonsense syllables shown on revolving drums and auditory presentation with 13 subjects. After a week the material was relearned. He stated that slow learning made for quicker relearning or better retention, since fewer repetitions were needed as the number of original repetitions increased. Pyle and others have pointed out that Whitehead's data do not support his conclusions, however, and that a positive correlation between retention and speed of learning exists.

In 1903, Henderson (17) conducted an experiment on connected trains of thought with 212 subjects, ranging from elementary to university graduate students. Five prose passages were read twice and then memorized within a three-minute time limit. Reproductions were called for immediately, after two days, and after four days. Henderson concluded that those "who learn quickest retain in general a greater percentage of what they have learned."

Ogden (12) in 1904 gave logical nonsense syllables to three subjects. The syllables were presented separately at different rates of speed. After an interval of 14 days the material was relearned. The resulting conclusion was that the fast learner seldom requires more and usually requires less time for relearning than the slow learner does.

In 1907 Radossavljewitsch (21) experimented with 18 adults and 11 children as subjects. As learning material he used lists of 8, 12, and 16 nonsense syllables and stanzas of poetry. Material was read until the subjects were able to meet the standard of two repetitions without error. Relearning took place after 24, 48, 72, 96, and 120 hours. Greater economy in relearning was found among slow learners, and the experimenter concluded that rapid learners were inferior in retention to slow learners.

Gamble's experiments (21), begun in 1908 and continued for several years, revealed a positive correlation between retention and speed of learning. In one study, 350 college students learned words and figures. The material was read four or five times to the subjects and presented again after five or six weeks. Three methods were used: in Method I, retention was measured by the amount reproduced; in Method II, material was read once more to the subjects before reproduction; and in Method III, material was read several times before reproduction. While Method I was found to yield a positive correlation between speed of learning and retention, results for Method II were doubtful. With Method III, a marked positive correlation was found. In another study, Gamble had his subjects learn nonsense syllables. The time between learning and relearning varied with different subjects. Only a slight positive correlation was found between facility of learning and retention.

Twenty-two adult subjects learned a German-English vocabulary in an experiment conducted by Thorndike (37) in 1908. Ten paired associates in each of ten lists were studied for one hour. The lists were

studied until each set had been studied five times. Retention was tested on 120 words at different intervals over a period of 37 days. A rank difference correlation of .40 was found between retention and speed of learning. Another investigation by Thorndike (38) in 1910 treated five lists of 12 words each as learned by 40 adults. The list was read once to a subject at the rate of one word per second. Recall after 24 hours led to a correlation of $.55 \pm .1$ (raw) or $.80 \pm .1$ (estimated true) between number of words recalled immediately and after the interval.

According to a report in 1910, Lewis (33) conducted an investigation using series of 15 nonsense syllables each and series of 15 monosyllabic sense words each. Every series was shown three times to the subject. Reproduction was tested immediately and on the following day after one additional repetition. Correlations between speed and retention as measured by relearning were .64, .81, and .76 for sense materials and .78, .75, and .84 for nonsense materials.

In 1911 Busemann (21) used lists of various parts of speech and simple syllables with children 12 to 18 years of age. The material was completely memorized. When tested on the amount of time necessary for relearning, the slow learner required less. While Busemann considers his experiments insufficient, he states that "it has not yet been proven that a greater ability to learn corresponds to a smaller degree to retain; on the contrary it is probably true that the good learner is at the same time a good retainer."

One of the most detailed studies of the problem was made by Pyle (30). In 1911 he conducted an investigation of the learning of early prose passages on nature study. The subjects were 12 senior and graduate college students. The same method of reading aloud by the subject, reading silently by the subject, and reading aloud by the experimenter was used until 40 ideas were memorized. The material was recalled after 24 hours. The conclusion was that "the fast learner is at no disadvantage in retention." Pyle states: "This would seem to indicate that if the learning of the same material by different learners is carried to the same point of organization there may be little difference in retention. The curves of learning and retention for this experiment show that the same amount of material was learned in shorter and shorter time as the experiments progressed, although the retention remained practically as good for the faster learning as it had for the slower learning."

Likewise, Pyle (32) tested subjects on nonsense syllables, 25 in a series. Subjects learned these syllables on the first day and relearned them with various repetitions on succeeding days. Reproduction followed 24 hours after the final learning. Those quick in the first learning were quick in the relearning.

In a study of 600 children in 1913 by Pyle (31), a high correlation was found between immediate memory and retention after a period of five weeks. The prose passage was read aloud once by the experimenter. Correlations of the number of items recalled at once and after the interval were .76 for the first group and .70 for the second group of children.

A correlation of .41 was found between the number of words learned and the number reinstated in an experiment by Norsworthy (26) in 1912. This was followed by a correlation of .50 on a second test. A

list of 1,200 words of a German-English vocabulary was studied by 83 college students over a learning period of 20 minutes for five days. After two days elapsed, the list was reviewed. After another two-day interval, the list was again reviewed and the first test was given. A month later the material was again tested.

In studying the curve of forgetting, Bean (3) in 1912 gave meaningless subject-matter, which was reproduced after intervals of 1 to 28 days. During a period of seven days the slow learners forgot 42.3 per cent more than the fast learners.

In an investigation in 1913, Finkenbinder (7) used nonsense syllables, 1,000 in number, combined in groups of 12 each. The 14 subjects were asked to avoid associations in learning. Every two seconds a syllable was presented until the observer could predict the one to appear next. Relearning followed after 30 minutes and after 1, 2, 4, 8, 12, 16, 24, 36, 48, and 72 hours. A comparison of the number of repetitions required revealed that the four most rapid learners were approximately two per cent more efficient that the four slowest learners. Concluding that the data were insufficient, the experimenter states that "rapid learners may remember more than slow learners."

Meumann (24) found that the person "who learns rapidly also forgets rapidly."

Woodworth (42) in 1914 experimented with 20 Italian-English words. After one reading by the subject, the experimenter read the Italian words until correct English equivalents were given. Each pair was dropped from the list to prevent overlearning as soon as one perfect recall was made. The list was presented as a whole after all the pairs had been learned. Recall after an interval of 2 to 20 hours led to the conclusion that the most rapid learners retain most.

Myers (25) in 1916 tested 50 school girls with words and figures, the time being unlimited both for learning and recall. Recall time related to learning time gave a correlation of –.38. "It probably means that the individual who took plenty of time in making certain her learning was more certain in her reproduction. . . ."

Perhaps the most complete study made is that of Lyon (21) in 1916. Twelve groups of convicts, insane people, and college, high school, and elementary school students—a total of 426—learned digits, nonsense syllables, words, prose, and poetry in any manner desired until they could be repeated without error. Three methods were used: 1, recall after learning; 2, recall after one presentation; and 3, relearning. Digits and nonsense syllables were reproduced after three days to one week; the remaining materials were reproduced after three to ten weeks. Positive correlations were found with the first two methods. With the third method the quick learner retained less. Considering all materials and methods, except for digits, the fastest learners forgot the least. Lyon emphasizes the dependence of a positive correlation, however, on method, material, and interval. With illogical material, a negative correlation resulted.

Boswell and Foster (4) also investigated the relation of retention to speed of learning in 1916. Four adults learned a Chinese-English vocabulary of eight series of 16 pairs each. Each pair was exposed a few seconds for 16 times, and two pairs were learned a day. English

equivalents were recalled after an interval of two weeks. Rank difference correlations between immediate and delayed recall were .00 for permanent and –.25 for temporary retention.

In 1916 J. Peterson (28) experimented with two groups of 12 and 29 subjects respectively with two lists of 20 words each. One list was copied by the students with intent to learn (active) and one without (passive). Recall after two days led to the conclusion in favor of rapid learners. Correlations ranged from .23 for passive learning to .68 for active learning.

Three adults learned poetry by the whole method for Henmon (18) in 1917. Relearning after 24 hours favored the rapid learners.

In 1918 Gates (11) gave nonsense material and biographies to 299 subjects of grades 3 to 8. A time limit of nine minutes was given for learning, with recall after three or four hours. The resulting correlations, according to various age levels and time intervals, were high.

Vlaicou (12) in 1920 gave numbers to 56 boys and 56 girls. The numbers were presented visually and were read and recited until they were completely learned. Recall and relearning after an eight-day interval gave a resulting correlation of –.25 (Pearson formula) between learning score and per cent saved in relearning.

A positive correlation was found in a study by Smith and McDougall (35) in 1920. Ten nonsense syllables were exposed separately on a rotating drum to two adults. Relearning followed after intervals of 24 hours and 7 to 18 days.

Luh (20) in 1922 tested two groups of ten subjects with nonsense syllables, 12 in a series. Relearning followed at intervals of 20 minutes; one, two, and three hours; and one and two days. As a rule, Luh states, the fast learners are the better retainers. However, with the recognition method the correlation between speed of learning and retention diminishes and becomes negative as the interval becomes longer; a positive relationship, if any, is found with the method of written reproduction.

Forty-eight words were memorized by 531 subjects in an experiment by Brown (6) in 1924. Each word was read aloud and was used in a phrase. Three methods of testing retention were employed: immediate written recall, recall after an interval with learning of nonsense syllables during the interval, and recall after a longer interval. The time intervening ranged from eight minutes to seven days. A positive correlation was found between speed of learning and retention.

Correlations ranging from .42 to .71 between recall after a few weeks' interval and immediate recall were found by Gordon in 1925. Four groups of subjects were used. Group I (101 persons) read the Athenian Oath six times in succession. They were asked to reproduce it immediately and after a four weeks' interval. A correlation of .42 was found between immediate and delayed recall. Group II (74 persons) read the Oath three times in succession. After three days this procedure was again used. Reproduction immediately and after four weeks led to a correlation of .70. Group III (40 persons) read the Oath three times in succession and reproduced it at once and after three weeks. The correlation was .52. Group IV (82 persons) read the Oath three times with an interval of one week between the first and second reading and one week between the second and third reading.

Reproduction was called for after the third reading and after an interval of three weeks. The resulting correlation was .71.

In her book in 1917, Gordon (15) refers to an investigation with Italian-English equivalents which she carried out with five women. The vocabulary was studied for ten minutes daily for eight successive days. After intervals of three days and three weeks, the subjects who learned the most words retained the greatest percentages.

H. A. Peterson (27) in 1925 gave prose to 56 normal girls of school age. Two methods were used, reproduction after two and a half minutes of study and after unlimited time. Recall followed an interval of one week. High positive correlations between speed of learning and retention were found.

Stump (36) investigated the learning of civics material by 16 high school seniors in 1927. Correlations of the amount learned and the amount retained after 14, 28, and 42 days were in favor of the rapid learner as the best retainer.

Similar results were found by Anderson and Jordan (1) in 1928. English-Latin equivalents of 250 words were given to 30 pupils, and tests were held at once and over an interval of eight weeks.

A more recent investigation of the problem is that made by Gillette (12) in 1936. Three methods were used. The two methods of equal amount learned and equal opportunity to learn were checked by the third, adjusted learning. According to the first, 54 students studied paired associates of different types to the point of one perfect repetition. Retention was measured by the amount recalled after a five-day interval and by the number of trials necessary for relearning after five days. Correlations showed that the fast learner tended to be the better retainer. In the second method 149 subjects studied paired associates, the time being held constant. The two series of ten pairs each were presented four times. Subjects were tested at once and after 48 hours. The second series was given in three weeks and the procedure was the same. Resulting correlations revealed approximately the same proportion of losses for fast and slow learners.

The final method employed by Gillette was that of adjusted learning. Twenty cards of picture-number pairs were presented to 25 children. To prevent overlearning, a pair was removed as soon as a correct response was made. Tests were given immediately and after 48 hours. Stating that this substantiates earlier results, Gillette concludes that the "tendency is decidedly toward better retention by fast learners."

A summary of the various studies discussed reveals some interesting information concerning the (1) number of subjects, (2) methods of learning, and (3) methods of measuring retention.

Number of Subjects. The number of subjects used varies with the experiments. The range is from 1 to 600, with the median falling at 30. Obviously, conclusions based on only 4 or 12 cases would be of less significance than those dependent on a wider sampling.

Methods of Learning. The majority of the studies discussed here might be classified according to complete and partial learning. According to the term "complete learning," tests are given only when the subjects think that they have totally mastered the material. In most

cases the amount to be learned is the same for all learners, but the time is unlimited. Studies involving this method are those by Ebbinghaus, Müller and Schumann, Whitehead, Ogden, Radossavljewitsch, Busemann, Henmon, Vlaicou, Smith and McDougall, Lyon, Luh, Gamble, Finkenbinder, Myers, and Bean. This method is believed to have one serious defect. When unlimited time is given, some pupils may not consider mastery complete unless they overlearn the material. This favors the slow learner in recall.

The method of partial learning allows for limited time, but the amount of material varies with the speed of learning according to the ability of the individual. Since the time is constant for all subjects, the fast learner has an opportunity to learn more and thus to recall more than the slow learner. This method, therefore, is thought to favor the fast learner. Studies which utilize this plan are those by Thorndike, Norsworthy, Boswell and Foster, J. Peterson, Gates, Brown, Henderson, Anderson and Jordan, Stump, and Gordon.

Those using both complete and partial learning are H. A. Peterson and Pyle.

To combat the difficulties of these methods, another one has been formulated by Woodworth and used by Gillette. This method of adjusted learning is thought to equalize opportunities between fast and slow learners. According to the plan, presentation of material to the learner is followed by a test. The material remembered correctly is drilled upon. Testing and additional practice are resumed until the complete list or a given number is learned.

Methods of Measuring Retention. Retention has been measured by recall, by recognition, and by relearning, or by all three. Critics censure these methods on much the same grounds as the methods of learning. They contend that overlearning by a slow learner would lead to better recall than learning up to the point of one correct response. Overlearning would, of course, facilitate relearning. Another factor influencing correlations is that of speed in relearning. The individual who learns rapidly doubtlessly will relearn rapidly. Thus correlations between the first learning and recall or relearning may not give a true picture.

Investigators using recall as the means of measuring retention are Henderson, Thorndike, Pyle, Anderson and Jordan, Woodworth, Norsworthy, Bean, Myers, Boswell and Foster, J. Peterson, Gates, Brown, H. A. Peterson, Stump, and Gordon. Those using relearning are Ebbinghaus, Müller and Schumann, Whitehead, Ogden, Radossavljewitsch, Busemann, Henmon, Smith and McDougall, and Finkenbinder. Those using both recall and relearning are Gamble, Lyon, Gillette, and Luh.

In most cases the relation between the original learning and recall or relearning is measured by means of correlation. Two difficulties in correlation (overlearning and speed of relearning) have been mentioned. Another objection has been the inaccuracy resulting from errors of measurement. Thorndike (39) pointed out that initial scores contained chance errors and that, when initial scores and gains were correlated, the results were more negative than the true relation. Likewise, correlations between initial scores and losses were more positive than the true relation.

Conclusions. Regardless of the methods used, a list of the experimenters who conclude that the fast learner is the better retainer, those who favor the slow learner as the better in retention, and those who found little or no significant difference shows the conflicting results concerning the extent of the relation between retention and speed of learning. Those experimenters who conclude that the fast learner is the better retainer are Ebbinghaus, Müller and Schumann, Gamble, Henderson, Thorndike, Norsworthy, Woodworth, Bean, Lyon, J. Peterson, Henmon, Gates, Smith and McDougall, Gordon, Luh, Brown, H. A. Peterson, Stump, Anderson and Jordan, and Gillette.

Those who contend that the fast learner relearns more rapidly but does not save as great a percentage in relearning are Ebbinghaus, Müller and Schumann, Ogden, Lewis, Radossavljewitsch, Busemann, Henmon, Vlaicou, and Smith and McDougall.

Those in favor of the slow learner as the better retainer include Whitehead (although his results are thought not to substantiate his conclusions), Meumann, Myers, Radossavljewitsch, and Boswell and Foster.

A few experimenters find no significant distinction in retention by the fast and slow learners. In his chief investigation, Pyle concludes that the "fast learner is at no disadvantage in retention" and states his belief that few differences may exist if the different learners carry learning of the same material to the same point of organization. (Other investigations led Pyle to favor the fast learner as the better retainer.) Since his experiment showed only two per cent greater efficiency for rapid learners, Finkenbinder concludes that "rapid learners may remember more than slow learners." Likewise, Busemann states that "it is probably true that the good learner is at the same time a good retainer." Ogden believes that the fast learner seldom requires more and usually requires less time for relearning than does the slow learner.

To conclude, the methods in many of the studies contain faults. Likewise, the number of cases used is too few in many instances to make the data statistically significant. A few investigators find no outstanding distinctions between fast and slow learners. Nevertheless, the majority of the studies made seem to favor the fast learner as the better retainer. While a rapid learner can usually relearn rapidly, many investigators believe that he is sometimes at a disadvantage when no opportunity for relearning is presented.

EXPERIMENTAL CONDITIONS

The experimental conditions of the study were as follows:

Subjects. The subjects[1] were an unselected group of 24 college freshmen. The age range of the subjects was from 18 to 21 years. Eight of the subjects were girls and 16 were boys. The ability range of the subjects as measured by their percentile ratings[2] was from 9 to 98, with

[1] These subjects were paid by the National Youth Administration for the time they spent as subjects of research.

[2] L. L. Thurstone and Thelma Gwinn Thurstone. *American Council on Education Psychological Examination for College Freshmen.* The American Council on Education, Washington, D.C., 1936. 11 p.

an average of 55. The average percentile rating of the subjects was about five points higher than the average for their class in the university.

Laboratory. All learning and subsequent memory tests were conducted in a quiet, well-lighted laboratory which was free from distractions. In order to avoid the distractions which might be present in a large study group, the subjects were divided into two approximately equal sections, which met at different hours of the same afternoon. The order of hours was rotated in order to equalize any advantage or disadvantage that might arise from the first or second hours of meeting. Unless a subject who participated in the original learning was also present for all memory tests and relearnings, his data are not included in that phase of the study. From time to time students were absent from the laboratory on testing days because of illness or other emergencies. Therefore, in no phase of the study are complete data available for the entire group of 24 subjects.

Degrees of Learning. In order to determine the relation between retention and speed of learning, this investigation studies three degrees of learning: (1) partial learning, (2) complete learning, (3) overlearning.

1. Partial learning refers to that degree of learning in which the subjects as a group did not learn all of the material that was presented. In learning each type of material the subjects were given a certain specific number of study periods. The methods of presenting material varied with the type of material to be learned. Regardless of the method of presentation, each study period is designated as a trial. The length of time for each trial was constant for each type of material. Attempted written reproduction followed each learning trial. These reproductions were checked by the experimenter, and learning trials were stopped as soon as the most rapid learners were able to reproduce a complete or nearly complete reproduction. By using this method, the slowest learner had accomplished something, and few if any of the rapid learners had completely learned the material.

2. Learning trials for complete learning were similar to those for partial learning. For complete learning, however, each subject continued with learning trials and attempted (written) reproductions until one accurate reproduction was achieved. As soon as the subject had made an accurate reproduction of the material he left the laboratory.

3. The procedures followed in overlearning were similar to those for partial and complete learning with the exception that learning trials for each type of material were continued until two consecutive accurate (written) reproductions were achieved.

Learning Materials. Since the relation of retention to speed of learning may vary with the type of material learned, six different types of learning material were selected: (1) nonsense syllables, (2) words, (3) names and dates, (4) geometric figures, (5) symbols, and (6) poetry. Three comparable sets of each type of learning material were prepared: one set for partial learning, one for complete learning, and one for overlearning.

Learning Procedure. The learning procedure varied with the type of learning material used.

1. Each of the three lists of nonsense syllables consisted of 15 nonsense syllables. One of these lists is shown in Figure 1.

1. hof	6. muk	11. toz
2. pam	7. seg	12. lub
3. wok	8. ron	13. ruv
4. zut	9. zof	14. hiv
5. bip	10. nok	15. koj

Fig. 1. An Example of the Nonsense Syllables.

Each syllable was typed on a 3″ x 5″ card. Each subject was given a pack of cards, the syllables being in the same order in each pack. These were kept face down until the subjects were given the command to turn the pack face up. After five seconds the experimenter gave the command "turn" and the first card was turned face down, exposing the second card with the second syllable in the list. After each five-second interval, the experimenter gave the command "turn" until each of the 15 cards had been turned. Immediately following each learning trial, the subjects attempted to reproduce the list of nonsense syllables spelled correctly and in the order in which they appeared on the cards.

2. There were 25 words in each of the three lists of words. The list given in Figure 2 is typical of this type of material.

1. cantaloupe	9. maneuver	18. dissension
2. embarrassment	10. miscellaneous	19. jardiniere
3. poultice	11. penitentiary	20. naphtha
4. rendezvous	12. souvenir	21. picnicking
5. syndicate	13. hallelujah	22. rarefy
6. appendicitis	14. inflammable	23. vilify
7. chauffeur	15. rhinoceros	24. desiccate
8. hippopotamus	16. conscientious	25. plaguy
	17. discernible	

Fig. 2. An Example of a List of Words.

The words were read orally by the experimenter at the rate of one word each five seconds. Following each learning trial, the subjects attempted to reproduce the 25 words in the order in which they had heard them read.

3. The list given in Figure 3 illustrates the type of material called "names and dates." The list used in partial learning contained 27 names and dates; in complete learning, 19; and in overlearning, 20.

1. 1919.....Sir Barton	11. 1929.....Clyde Van Dusen
2. 1920.....Paul Jones	12. 1930.....Gallant Fox
3. 1921.....Behave Yourself	13. 1931.....Twenty Grand
4. 1922.....Morvich	14. 1932.....Burgoo King
5. 1923.....Zev	15. 1933.....Brokers Tip
6. 1924.....Black Gold	16. 1934.....Cavalcade
7. 1925.....Flying Ebony	17. 1935.....Omaha
8. 1926.....Bubbling Over	18. 1936.....Bold Venture
9. 1927.....Whiskery	19. 1937.....War Admiral
10. 1928.....Reigh Count	

Fig. 3. An Example of Names and Dates.

Each name and date combination was typed on a 3" x 5" card and these were read by the experimenter at the rate of one each five seconds. On the first reading the names and dates were read in the order of date. On the second reading and on all subsequent readings, the cards were shuffled before each reading. The order of reading was number, name, date. Attempted reproductions followed each learning trial.

4. Each of the three lists of geometric figures consisted of 12 geometric designs, each design being in a definite position in the list. An example of the geometric figures and their organization is given in Figure 4.

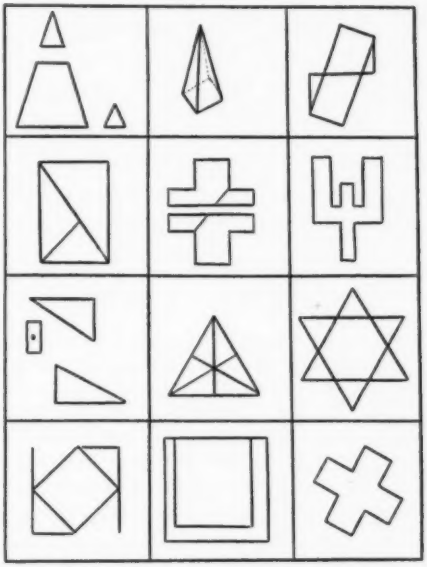

Fig. 4. An Example of the Geometric Figures.

The sets of geometric figures were mimeographed and the mimeographed sheets were pasted on heavy cardboard so that the designs would not show through the paper. At the beginning of the learning period each subject was given one of the sets, face down. The subjects were informed that on the other side of the cardboard there were 12 figures, each figure in a particular square, and that they would be given ten seconds for studying these figures and their position in relation to each other. On the command "turn" the sheets were turned face up, and at the end of the ten-second study period they were turned face down again. Each subject was given a sheet of paper with squares drawn on it and was asked to reproduce the correct figures in the correct squares.

5. Each of the three lists of symbols consisted of 30 symbols and their translation.[1] The list given in Figure 5 is typical of the three lists used.

[1] In scoring these, one point was given for each correct symbol and one point for each correct translation, making a total possible score of 60. For this reason this test will be referred to hereafter as the 60 symbols.

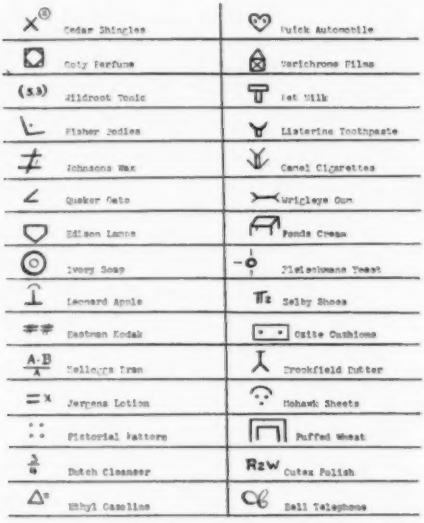

Fig. 5. An Example of the Symbols.

The sets of symbols and translations were mimeographed and the mimeographed sheets were pasted on heavy cardboard so that the design of the symbols would not show through the paper. One of these sets was given, face down, to each subject with the information that he would be given one minute for studying the 30 symbols and 30 translations on the other side of the sheet. Following each one-minute study period, subjects were asked to reproduce the symbols and translations on sheets of paper, lined like the original study sheets, but without either the symbols or translations.

6. Each of the three examples of poetry consisted of a 14-line stanza of approximately 100 words. That used for partial learning contained 110 words; for complete learning, 115 words; and for overlearning, 99 words. The stanza given illustrates the type of poetry used.

A very pitiful lady, very young,
Exceeding rich in human sympathies,
Stood by, what time I clamor'd upon Death
And at the wild words wandering on my tongue
And at the piteous look within mine eyes
She was affrighted, that sobs choked her breath.
So by her weeping where I lay beneath,
Some other gentle ladies came to know
My state, and made her go;
Afterward, bending themselves over me,
One said, "Awaken thee!"
And one, "What thing thy sleep disquieteth?"
With that, my soul woke up from its eclipse,
The while my lady's name rose to my lips:

Fig. 6. An Example of the Poetry.

The poetry was mimeographed and each subject was given a stanza, face down. On the command "turn" the subjects turned their sheets and studied the poetry for 30 seconds and then were commanded to turn their sheets over again. Following each 30-second learning trial, the subjects attempted written reproduction of the stanza of poetry. Subjects were informed that incorrect spelling and punctuation would not count as errors.

Interpolated Material. Although there was no opportunity for the subjects actually to review the material, there was the possibility that they might attempt to reconstruct the material in anticipation of memory tests. To guard against this possibility, a great variety of materials other than nonsense syllables, words, names and dates, geometric figures, symbols, and poetry were learned. For some of these interpolated materials retention was frequently tested; for others retention was measured only occasionally, if at all. None of the data secured from the interpolated materials is included in the results.

Scoring. The scoring was constant for each type of learning material, regardless of the degree of learning. The number of correct items reproduced for any learning trial, memory test, or relearning trial constituted the score, except that, in the list of symbols, each symbol and each translation was considered a separate item. For an item to be correct, it had to appear in the reproduction in the same position as it appeared in the learning situation. Spelling was considered only in the case of nonsense syllables, which had to be correctly spelled to be considered correct. When the reproductions were scored for the learning trials in complete and overlearning and in the relearning trials for these degrees of learning, the subject was informed as to whether or not his reproduction was correct, but in no event was he informed of his specific errors.

Measurement of Speed of Learning. In the case of partial learning, speed of learning in all six types of material was measured by the score made on the test following the last learning trial. The number of learning trials varied with the type of material. Three trials were given for nonsense syllables, four for words, four for names and dates, four for geometric figures, five for symbols, and six for poetry. In complete learning, speed of learning was measured by the number of trials the subject required to produce one correct written copy of the material to be learned. In overlearning, speed of learning was measured by the number of trials the subject required to produce two correct, consecutive written copies of the material being learned.

Distribution of Memory Tests and Relearning Trials. The distribution of memory tests and relearning trials for the three degrees of learning—partial, complete, and overlearning—is given in Table I. For each degree of learning there were seven memory tests. The memory tests for partial learning were distributed over a period of approximately 80 days. There were slight variations in the total number of days elapsing between learning and the final memory test for the different types of materials. The length of time between the memory tests was not constant

except for the first memory test, which was seven days following the learning. The memory tests for complete learning were distributed over a period of time varying from 101 days for poetry to 132 days for words. The number of days elapsing between the memory tests for each type of material may be seen by examining Table I. For overlearning the memory tests covered a period of approximately 60 days. The study of words took only 52 days, the shortest period of time between learning and the seventh memory test.

TABLE I. NUMBER OF DAYS ELAPSING BETWEEN LEARNING AND THE MEMORY TESTS AND RELEARNING TRIALS FOR EACH OF THE THREE DEGREES OF LEARNING

Type of Learning	First memory test	First relearning	Second memory test	Second relearning	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning	Seventh memory test	Third relearning
Partial Learning											
Nonsense syllables	7	.....	17	.....	27	41	52	66	.....	80	80
Words	7	.....	22	.....	34	44	56	68	.....	83	83
Names and dates	7	.....	17	.....	31	42	56	69	.....	83	83
Geometric figures	7	.....	17	.....	29	42	53	64	.....	81	81
Symbols	7	.....	21	.....	33	47	57	70	.....	84	84
Poetry	7	.....	21	.....	33	43	56	68	.....	82	82
Complete Learning											
Nonsense syllables	7	7	33	.....	54	65	75	99	99	123	123
Words	7	7	27	.....	55	75	90	102	102	132	132
Names and dates	7	7	28	.....	42	62	73	85	85	121	121
Geometric figures	7	7	28	.....	53	66	77	98	98	108	108
Symbols	7	7	29	.....	41	52	67	78	78	108	108
Poetry	7	7	27	.....	37	47	62	73	73	101	101
Overlearning											
Nonsense syllables	7	7	16	16	36	43	50	59	.....	63	63
Words	7	7	14	14	28	33	40	48	.....	56	56
Names and dates	7	7	15	15	30	35	42	49	.....	58	58
Geometric figures	7	7	14	14	33	40	49	54	.....	61	61
Symbols	7	7	14	14	40	47	54	61	.....	68	68
Poetry	7	7	14	14	28	30	37	44	.....	52	52

The subjects were given no information concerning the memory tests. Neither did they know that much of the material learned did not constitute a part of the results of the study.

In partial learning there was only one series of relearning trials; this followed the seventh memory test. Each subject was given two consecutive relearning trials for each type of material. In complete learning there were three series of relearning trials, the first following the first memory test, the second following the sixth, and the third following the seventh memory test. Relearning trials were continued until each subject achieved an accurate reproduction of the material. There were also three series of relearning trials in overlearning, the first following the first memory test, the second following the second memory test, and the third following the seventh memory test. The relearning trials for overlearning were continued until each subject achieved an accurate reproduction of the material. In all cases relearning trials immediately followed the memory test.

RESULTS

The data are organized in three sections according to the degree of learning: I, partial learning; II, complete learning; and III, over-

learning. The order of presentation of data in each section is: 1, nonsense syllables; 2, words; 3, names and dates; 4, geometric figures; 5, symbols; and 6, poetry.

I. Partial Learning

In partial learning, speed of learning for each individual is measured by the score made on the test following the last learning trial, and retention is measured by recall (the scores made on each memory test) and by relearning (the score made on the test following the second relearning trial). In order to standardize the presentation and interpretation of the data, the same types of tables and graphs have been prepared for each kind of learning material.

On the first type of material studied, nonsense syllables, the subjects have been arranged in order from fastest to slowest in speed of learning and numbered consecutively in this order. On all the other types of material learned, the subjects are referred to by the numbers given them in the study of nonsense syllables.

In the discussion of each type of material in partial learning, three tables are included. The first shows the individual scores made on the test given after the last learning trial, on the seven memory tests, and on the test following the second relearning trial. In the second table, the rank of each subject on each memory test (as determined by the score) and his relearning rank (computed on the basis of scores made on the test following the second relearning trial) are compared with rank on speed of learning. Correlations are computed by the rank method, first determining "rho" and then transferring to "r." In the third table, group trends are determined by dividing the subjects into three groups—upper third, middle third, and lower third—on the basis of the learning scores and by comparing the average learning, memory test, and relearning scores of these groups.

Besides the tables, there are two figures included in the discussion of each type of material, both of which are based upon percentages. Percentages for learning and relearning scores are computed on the basis of the maximum number of items to be learned; and those for memory test scores are computed on the basis of the number of items learned in the original learning by each subject.

In the first figure in each section, which shows the efficiency of recall, the seven lines making up each bar represent the percentage scores on the seven memory tests, in order from first to last. The subjects are ranked according to their speed of learning and the groups of lines are arranged in order from fastest to slowest learners from left to right. The second figure shows the average learning, memory test, and relearning scores made by each third of the group. The bar at the left represents the percentage learned by each third of the group; the three lines connecting the two bars represent the average percentage recalled on each memory test; and the bar at the right represents the percentage relearned.

1. Nonsense Syllables. The seven memory tests following the partial learning of the 15 nonsense syllables were given at intervals of 7, 10, 10, 14, 11, 14, and 14 days. Relearning following the seventh mem-

ory test was 80 days removed from the original learning (Table I). The learning, memory test, and relearning scores made by each subject are given in Table II, the subjects being listed in the order of their score on the original learning. Subject 1 learned the entire list of 15 nonsense syllables and Subject 21, at the bottom of the list, learned only 4. Thus, Subject 1 learned approximately four times as fast as Subject 21. Subject 1 recalled 8 of the nonsense syllables on the first memory test, and Subject 21 was unable to recall even one syllable.

The scores in Table II, read from left to right, indicate the relation between the retention and speed of learning of an individual. When read from top to bottom, they show the relation of the 21 subjects to one another on both retention and speed of learning.

TABLE II. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 15 NONSENSE SYLLABLES IN PARTIAL LEARNING

Subject	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
1	15	8	5	8	8	6	5	6	15
2	14	5	6	6	7	2	2	5	14
3	14	2	3	4	5	5	4	3	12
4	12	0	1	0	2	0	0	0	11
5	12	2	3	3	2	0	4	2	15
6	12	3	1	3	2	2	3	2	12
7	12	0	6	4	3	2	2	2	13
8	11	0	0	1	2	1	1	2	13
9	11	1	1	1	3	2	0	2	12
10	11	5	4	5	7	5	5	3	12
11	11	7	6	7	6	5	5	2	13
12	11	3	4	3	5	5	2	4	12
13	11	8	9	8	10	10	8	5	15
14	11	5	5	6	4	2	2	5	11
15	9	0	2	0	0	0	0	1	10
16	8	0	1	2	3	3	2	2	10
17	7	0	2	2	2	2	2	0	8
18	7	4	6	4	1	2	2	2	10
19	6	2	2	3	4	3	2	4	13
20	6	1	2	1	1	1	0	2	9
21	4	0	0	0	1	0	0	0	6

The memory test scores, expressed in percentages, are shown in graphical form in Figure 7. Most of the individual bars, made up of seven lines each, are bell-shaped. The predominance of this form indicates that ability to recall nonsense syllables improves with the passing of time until a certain period has elapsed between the learning and the highest memory score. This is followed by a gradual reduction in amount of syllable recall. In general, the highest percentage of what was learned by the subjects was recalled on the third, fourth, or fifth memory test, showing that recall was most efficient approximately 40 days after learning (Table I).

The contour of the whole group of 21 bars is also somewhat bell-shaped in appearance. This indicates that the subjects who learned nonsense syllables at an average speed tended to remember more of what they had learned than did those who learned them either faster or slower. There are, however, numerous individual cases where, on certain memory tests, a slow learner recalled more of what he had learned than an average or fast learner, and vice versa.

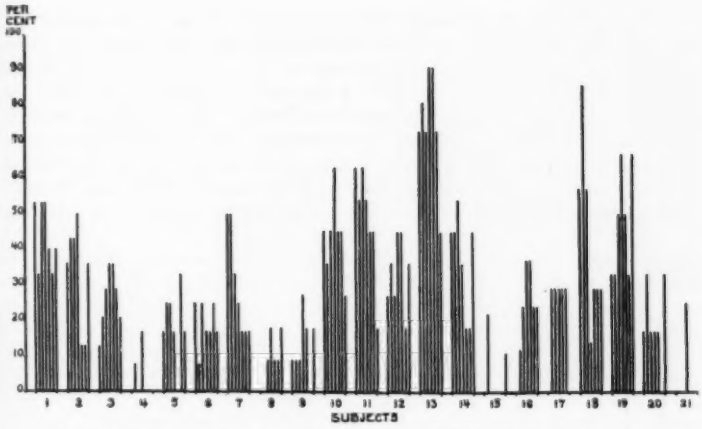

Fig. 7. Efficiency of Recall on the 15 Nonsense Syllables in Partial Learning.

The changes in rank of each subject are shown in Table III. Subject 1, who ranked 1 in speed of learning, ranked 1.5, 6.5, 1.5, 2, 2, 3, and 1 on the seven memory tests and 2 in relearning. Subject 13, who ranked 11 in speed of learning, ranked 1.5, 1, 1.5, 1, 1, 1, and 3 on the seven memory tests and 2 in relearning. Subject 21, who was the slowest learner of the 21 subjects, was relatively consistent in maintaining his position, ranking 18.5, 20.5, 20, 19, 19.5, 19, and 20 on the seven memory tests and 21 in relearning.

TABLE III. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 15 NONSENSE SYLLABLES IN PARTIAL LEARNING

Subject	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
1	1	1.5	6.5	1.5	2	2	3	1	2
2	2.5	6	3.5	4.5	3.5	12	11.5	3	4
3	2.5	12	10.5	8	6.5	4.5	5.5	7.5	11
4	5.5	18.5	17.5	20	15	19.5	19	20	14.5
5	5.5	12	10.5	11.5	15	19.5	5.5	13	2
6	5.5	9.5	17.5	11.5	15	12	7	13	11
7	5.5	4	3.5	8	11	12	11.5	13	6.5
8	11	18.5	20.5	17	15	16.5	16	13	6.5
9	11	14.5	17.5	17	11	12	19	13	11
10	11	6	8.5	6	3.5	4.5	3	7.5	11
11	11	3	3.5	3	5	4.5	3	13	6.5
12	11	9.5	8.5	11.5	6.5	4.5	11.5	5.5	11
13	11	1.5	1	1.5	1	1	1	3	2
14	11	6	6.5	4.5	8.5	12	11.5	3	14.5
15	15	18.5	13.5	20	21	19.5	19	18	17
16	16	18.5	17.5	14.5	11	7.5	11.5	13	17
17	17.5	18.5	13.5	14.5	15	12	11.5	20	20
18	17.5	8	3.5	8	19	12	11.5	13	17
19	19.5	12	13.5	11.5	8.5	7.5	11.5	5.5	6.5
20	19.5	14.5	13.5	17	19	16.5	19	13	19
21	21	18.5	20.5	20	19	19.5	19	20	21
Correlation*		.49	.35	.49	.54	.27	.50	.45	.09
P.E.$_r$		±.12	±.13	±.12	±.11	±.14	±.12	±.12	±.08

* In computing correlations, round numbers were used.

The tendency for the subjects to maintain a relatively constant ranking in learning, recall, and relearning indicates that there is some relation between the speed of learning a list of 15 nonsense syllables and the ability to recall it. This tendency is substantiated when the correlations of speed of learning with retention and relearning are examined (Table III). These correlations range from +.27 between speed of learning and the fifth memory test to +.69 between speed of learning and relearning. Although the P.E.'s are relatively high, the correlations are large enough to be somewhat significant.

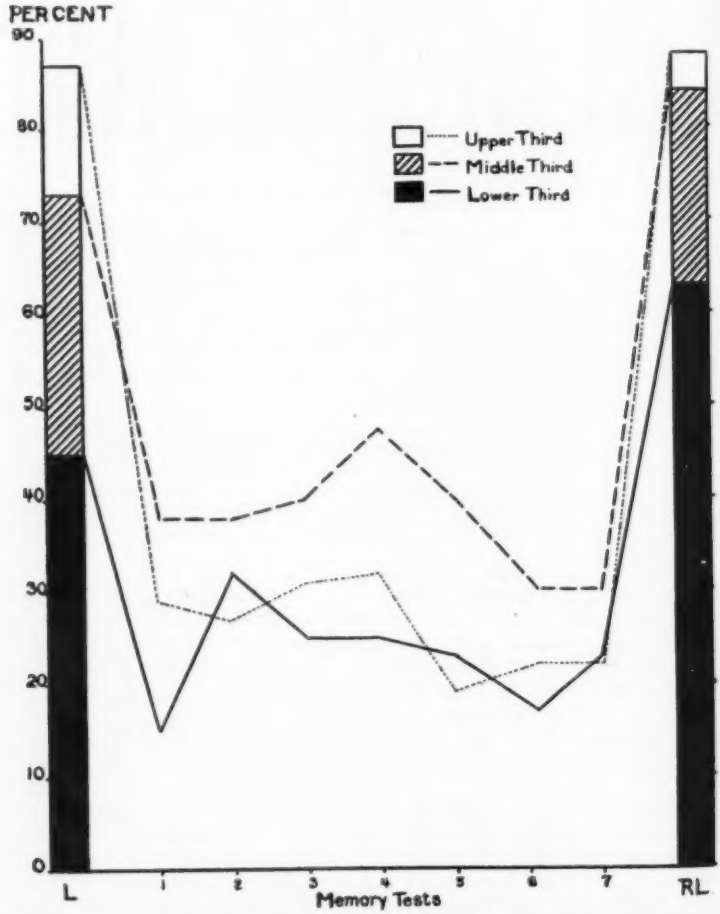

Fig. 8. Average Learning, Memory Test, and Relearning Percentage Scores Made by Each Third of the Group on the 15 Nonsense Syllables in Partial Learning.

The average learning, memory test, and relearning scores for the upper, middle, and lower thirds of the group are given in Table IV. The upper third learned an average of 13.0 nonsense syllables; the middle third, 11.0 syllables; and the lower third, only 6.7 syllables. The number of nonsense syllables recalled on each of the memory tests is approximately the same within each third of the group.

The relation between retention and speed of learning for the three groups is shown in Figure 8, which is based on percentages. On all seven memory tests the curve for the middle third is well above that of the curves for the upper and lower thirds, and, with the exception of the first memory test, the curves for the upper and lower thirds fall in approximately the same position. In relearning, the upper third of the group relearned 88 per cent of the 15 nonsense syllables, the middle third 84 per cent, and the lower third 63 per cent. All three groups relearned a higher percentage of the syllables than they had originally learned, the greatest gain being made by the lower third.

TABLE IV. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 15 NONSENSE SYLLABLES IN PARTIAL LEARNING

SUBJECT	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
Upper third	13.0	3.7	3.6	4.0	4.1	2.4	2.9	2.9	13.1
Middle third	11.0	4.1	4.1	4.4	5.3	4.3	3.3	3.3	12.6
Lower third	6.7	1.0	2.1	1.7	1.7	1.6	1.1	1.6	9.4

The data concerning the learning and recall of the 15 nonsense syllables shows three definite trends: (1) rapid learners tend to remember more of what they learn than do slow learners; (2) recall tends to be more efficient approximately 40 days after learning than it is either before or after this time; and (3) when the subjects are divided into three groups on the basis of their speed of learning, there is a tendency for the group consisting of those subjects who learn at an average speed to recall more of what they had learned than either the group of rapid or of slow learners.

2. Words. The seven memory tests following the partial learning of the 25 words came at intervals of 7, 15, 12, 10, 12, 12, and 15 days. Relearning following the seventh memory test was 83 days removed from the original learning (Table I). The learning, memory test, and relearning scores made by each subject are given in Table V, the subjects being listed in the order of their score on the original learning. Subject 8, who learned all 25 words, recalled only 2 words on the first memory test, while Subject 17, the slowest learner on this test, recalled 1 word. Thus, Subject 17 recalled a higher percentage of what he had learned than did Subject 8.

The scores in Table V, read from left to right, indicate the relation between the retention and speed of learning of an individual. When read from top to bottom, they show the relation of the 21 subjects to each other on both retention and speed of learning.

TABLE V. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 25 WORDS IN PARTIAL LEARNING

Subject	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
8	25	2	0	1	3	3	1	1	19
10	25	9	6	5	3	4	3	1	19
2	21	8	5	4	7	7	7	6	17
7	21	2	0	1	0	2	1	2	16
12	21	6	6	2	4	5	4	3	14
6	19	2	0	1	0	0	0	2	15
3	18	9	7	2	8	4	7	3	21
4	17	1	1	0	1	1	2	1	7
5	17	0	1	1	1	1	2	3	7
9	15	1	0	1	1	2	1	3	16
15	14	2	2	2	3	4	4	2	6
11	13	0	0	2	1	2	0	1	3
19	13	9	2	3	4	3	3	4	19
13	12	3	2	4	2	1	1	1	5
16	12	4	2	1	2	2	2	3	10
1	12	6	7	5	3	2	3	3	25
18	12	2	3	3	4	3	3	4	15
20	11	6	5	3	4	2	1	1	7
14	10	1	0	1	1	0	0	1	6
21	9	0	0	1	0	2	0	1	7
17	5	1	2	2	2	2	0	0	10

The memory test scores, expressed in percentages, are shown in graphical form in Figure 9. The individual bars show no definite trends in the shape of the memory curves. Some subjects recalled a greater percentage of what they had learned on the first memory test, gradually recalling less as memory tests were further removed from learning. Certain other subjects at first recalled very little of what they had learned, but reached their highest percentage of words on the final memory test. A few of the bars are bell-shaped, the highest percentage of recall being on the third, fourth, and fifth memory tests.

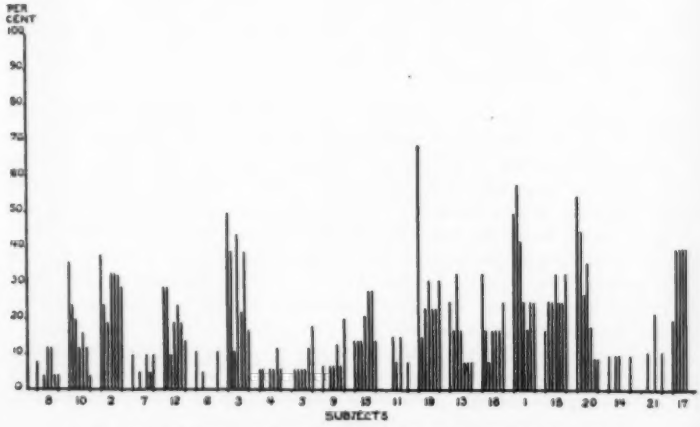

Fig. 9. Efficiency of Recall on the 25 Words in Partial Learning.

According to the figure as a whole there appears to be no tendency for those who learned fastest to recall a greater percentage of what they had learned than for those who learned more slowly. There are, however, individual cases in which rapid learners recalled more than slow learners, just as there are individual cases in which average and slow learners recalled more than fast learners.

The changes in rank of each subject are given in Table VI. Subject 8, who ranked 1.5 in speed of learning, ranked 12 on the first memory test, 18 on the second, and 16.5, 8.5, 7, 14, and 16.5 on the remaining five tests, and 4 in amount relearned. On the other hand, Subject 1, who ranked only 15.5 on the learning test, ranked 6, 1.5, 1.5, 8.5, 12.5, 6.5, and 6.5 on the seven memory tests and 1 on the relearning trial. The great variations in rank indicate that there is little relation between the ability to recall words and the speed at which they are learned.

Additional evidence that there is but little relation between speed of learning and retention is shown by the correlations of the scores on learning with those on the seven memory tests and the relearning. The correlations (Table VI) range from −.02 between speed of learning and the third memory test to +.51 between speed of learning and relearning. In all cases the P.E.'s are so large as to indicate that the correlations are too low to be significant.

TABLE VI. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 25 WORDS IN PARTIAL LEARNING

SUBJECT	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
8	1.5	12	18	16.5	8.5	7	14	16.5	4
10	1.5	2	3.5	1.5	8.5	4	6.5	16.5	4
2	4	4	5.5	3.5	2	1	1.5	1	6
7	4	12	18	16.5	20	12.5	14	11	7.5
12	4	6	3.5	10	4.5	2	3.5	6.5	11
6	6	12	18	16.5	20	20.5	19	11	9.5
3	7	2	1.5	10	1	4	1.5	6.5	2
4	8.5	16.5	13.5	21	16	18	10	16.5	15.5
5	8.5	20	13.5	16.5	16	18	10	6.5	18.5
9	10	16.5	18	16.5	16	12.5	14	6.5	7.5
15	11	12	10	10	8.5	4	3.5	11	18.5
11	12.5	20	18	10	16	12.5	19	16.5	21
19	12.5	2	10	6	4.5	7	6.5	2.5	4
13	15.5	9	10	3.5	12	18	14	16.5	20
16	15.5	8	10	16.5	12	12.5	10	6.5	12.5
1	15.5	6	1.5	1.5	8.5	12.5	6.5	6.5	1
18	15.5	12	7	6	4.5	7	6.5	2.5	9.5
20	18	6	5.5	6	4.5	12.5	14	16.5	15.5
14	19	16.5	18	16.5	16	20.5	19	16.5	18.5
21	20	20	18	16.5	20	12.5	19	16.5	15.5
17	21	16.5	10	10	12	12.5	19	21	12.5
Correlation		.25	.08	−.02	.18	.46	.47	.31	.51
$P.E._r$		±.14	±.15	±.15	±.15	±.12	±.12	±.14	±.11

The average learning, memory test, and relearning scores for the upper, middle, and lower thirds of the group are given in Table VII. The upper third learned an average of 21.4 words; the middle third, 14.4; and the lower third, 10.1. On all the memory tests, the upper third recalled as many or more words than either the middle or lower third

of the group; however, on the first four memory tests the lower third recalled more words than the middle third.

The relation between retention and speed of learning for the three groups may be more readily determined by examining the curves in Figure 10, which are based on percentages. In relearning, the upper third of the group relearned 69 per cent of the 25 words, the middle third relearned 36 per cent, and the lower third relearned 46 per cent. The lower third of the group was the only one which relearned a higher percentage of the words than it had originally learned, and even in this case there was a difference of only 5 per cent.

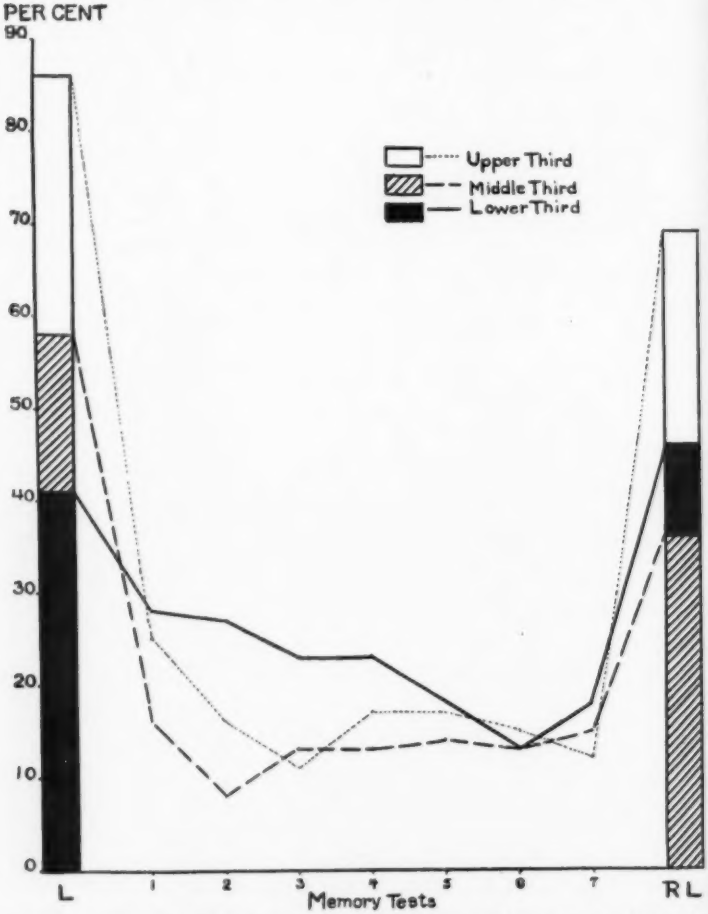

Fig. 10. Average Learning, Memory Test, and Relearning Percentage Scores Made by Each Third of the Group on the 25 Words in Partial Learning.

An evaluation of all the data concerning the speed of learning and the retention of the 25 words indicates that there is little, if any, relation between retention and speed of learning.

TABLE VII. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 25 WORDS IN PARTIAL LEARNING

SUBJECT	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
Upper third	21.4	5.4	3.4	2.3	3.6	3.6	3.3	2.6	17.3
Middle third	14.4	2.3	1.1	1.9	1.9	2.0	1.9	2.1	9.0
Lower third	10.1	2.9	2.7	2.3	2.3	1.9	1.3	1.9	11.4

3. Names and Dates. The seven memory tests following the partial learning of the 27 names and dates came at intervals of 7, 10, 14, 11, 14, 13, and 14 days. Relearning following the seventh memory test was 83 days removed from the original learning (Table I). The learning, memory test, and relearning scores made by each subject are given in Table VIII. The learning scores range from 8 to 27. Subject 1, who recalled all the names and dates, learned more than three times as fast as Subject 17, who learned only 8. On the first memory test Subject 1 recalled 26 of the names and dates, or 96 per cent of those he had learned, while Subject 17 recalled only 1, or 13 per cent, of those he had learned.

When the scores in Table VIII are read from left to right, they show the relation between retention and speed of learning for each subject, and, when read from top to bottom, they show the relation of the 22 subjects to one another on both retention and speed of learning.

TABLE VIII. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 27 NAMES AND DATES IN PARTIAL LEARNING

SUBJECT	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
1	27	26	25	26	24	20	21	21	27
10	24	13	13	14	16	15	13	13	26
14	23	10	7	6	11	10	4	6	20
5	22	8	7	10	10	12	7	5	22
7	22	15	14	14	17	15	14	13	26
19	21	13	11	7	8	11	10	10	15
2	20	11	13	11	8	8	8	6	23
3	20	10	10	9	10	7	10	7	24
13	20	12	14	13	13	13	14	11	21
18	19	8	12	13	14	14	14	13	25
22	19	11	11	9	9	8	9	10	19
16	18	8	11	15	16	12	12	9	23
8	17	4	8	5	7	3	6	3	19
15	16	14	14	14	14	14	14	14	19
9	15	8	7	7	9	8	7	6	16
20	14	3	7	5	7	5	2	5	17
4	13	2	4	2	1	3	2	0	13
6	13	1	3	0	2	2	2	1	9
11	13	1	1	0	0	0	0	0	11
12	13	4	4	3	2	4	6	1	17
21	9	5	3	6	7	7	6	3	13
17	8	1	2	2	2	1	2	2	7

The memory test scores, expressed in percentages, are shown in graphical form in Figure 11. The individual bars show that there are many variations in the shape of the memory curves, although there is a predominance of the bell-shaped curves. For a majority of the subjects a higher percentage of the names and dates that were learned were recalled on the third, fourth, or fifth memory tests than were recalled on the other tests.

The curve of the bars as a whole is somewhat skewed to the right, indicating that there is a tendency for the fast learners to recall a higher percentage of what they had learned than there is for the slow learners. There are exceptions, however, to this general trend: Subject 14, who ranked near the top in speed of learning, recalled a relatively small number of the names and dates; and Subject 21, who ranked near the bottom in speed of learning, recalled a relatively large number of the names and dates he had learned.

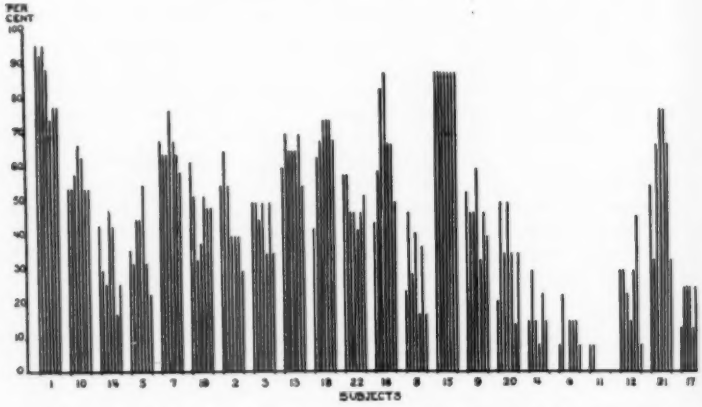

Fig. 11. Efficiency of Recall on the 27 Names and Dates in Partial Learning.

The changes in rank of each subject are given in Table IX. Subject 1, who ranked 1 in speed of learning, also ranked 1 on each of the seven memory tests and on relearning; and Subject 17, who was the slowest learner, ranked 21, 21, 19.5, 19, 21, 19.5, and 18 on the seven memory tests and 22 on relearning.

The tendency for each subject to maintain a relatively uniform ranking in both speed of learning and recall indicates that there is a rather close relation between the speed of learning 27 names and dates and the ability to recall them later. The correlations between the learning score and the memory and relearning scores are relatively high, the highest being between the learning score and the first memory test score, and the lowest between the learning score and the sixth memory test score. The P.E.'s are small, which adds to the significance of the correlations.

The average learning, memory test, and relearning scores for the upper, middle, and lower thirds of the group are given in Table X.

TABLE IX. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 27 NAMES AND DATES IN PARTIAL LEARNING

SUBJECT	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
1	1	1	1	1	1	1	1	1	1
10	2	4.5	5.5	4	3.5	2.5	6	4	2.5
14	3	9.5	14.5	14.5	8	10	17	12	10
5	4.5	12.5	14.5	9	9.5	7.5	12.5	14.5	8
7	4.5	2	3	4	2	2.5	3.5	4	2.5
19	6	4.5	9	12.5	13.5	9	8.5	7.5	17
2	8	7.5	5.5	8	13.5	11.5	11	12	7
3	8	9.5	11	10.5	9.5	13.5	8.5	10	6
13	8	6	3	6.5	7	6	3.5	6	9
18	10.5	12.5	7	6.5	5.5	4.5	3.5	4	4.5
22	10.5	7.5	9	10.5	11.5	11.5	10	7.5	12
16	12	12.5	9	2	3.5	7.5	7	9	4.5
8	13	16.5	12	16.5	16	18.5	15	16.5	12
15	14	3	3	4	5.5	4.5	3.5	2	12
9	15	12.5	14.5	12.5	11.5	15.5	12.5	12	16
20	16	18	14.5	16.5	16	15.5	19.5	14.5	14.5
4	18.5	19	17.5	19.5	21	18.5	19.5	21.5	18.5
6	18.5	21	19.5	21.5	19	20	19.5	19.5	21
11	18.5	21	22	21.5	22	22	22	21.5	20
12	18.5	16.5	17.5	18	19	17	15	19.5	14.5
21	21	15	19.5	14.5	16	13.5	15	16.5	18.5
17	22	21	21	19.5	19	21	19.5	18	22
Correlation		.82	.76	.73	.79	.80	.69	.73	.81
$P.E._r$		±.05	±.06	±.07	±.05	±.05	±.08	±.07	±.05

The upper third learned an average of 22.7 names and dates, which was 4.7 more than the middle group learned and almost twice as many as the lower third (11.9). On the first memory test the upper group recalled 13.7 of the names and dates it had learned, the middle group 9.4, and the lower third 2.4.

The difference in percentages recalled by the upper and middle groups is small. The relation between retention and speed of learning for the three groups is shown clearly in Figure 12, which is based on percentages. On all seven memory tests the curves for the upper and middle groups are well above the curve for the lower third, the difference being even greater on the memory tests than on speed of learning. The proximity of the curves for the upper and middle groups shows that they were about equally efficient in recalling the names and dates they had learned. There seems to be little difference in the relation between the rapid and slow learners in retention as measured by relearning and by speed of learning.

TABLE X. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 27 NAMES AND DATES IN PARTIAL LEARNING

SUBJECT	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
Upper third	22.7	13.7	12.9	12.6	13.4	13.0	11.0	10.6	22.7
Middle third	18.0	9.4	10.9	10.6	11.5	9.5	10.8	9.1	21.0
Lower third	11.9	2.4	3.4	2.6	3.0	3.1	2.9	1.7	12.4

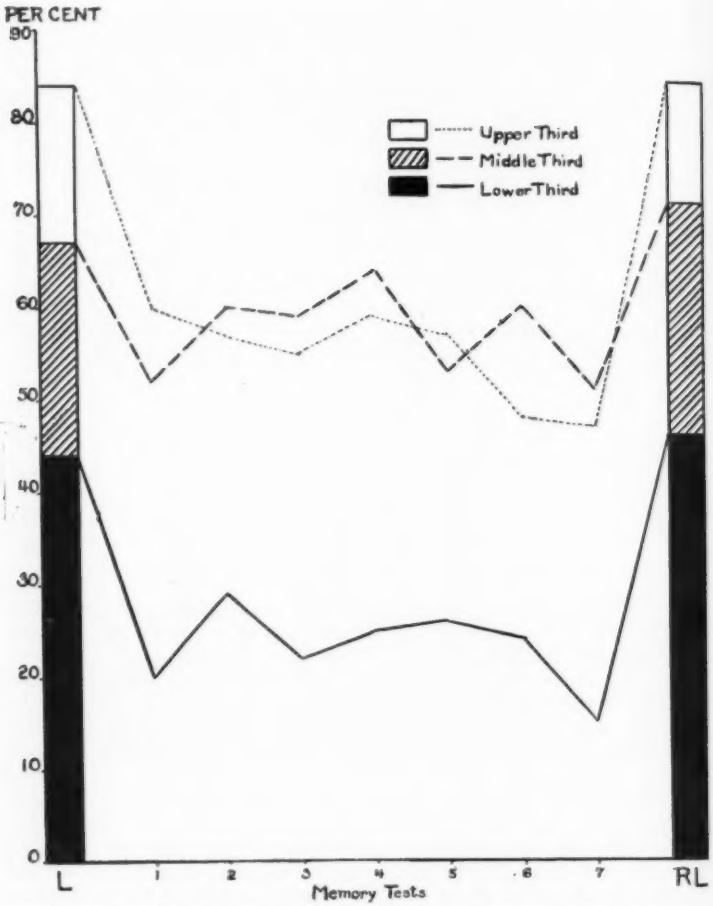

Fig. 12. Average Learning, Memory Test, and Relearning Percentage Scores Made by Each Third of the Group on the 27 Names and Dates in Partial Learning.

The data concerning the learning and recall of the 27 names and dates show that there is a very definite tendency for the rapid learners to recall more of what they learn than for the slow learners. When the subjects are grouped according to speed of learning and their memory scores are compared with speed of learning, the subjects learning at an average speed recalled as much of what they had learned as did the more rapid learners.

4. Geometric Figures. The seven memory tests following the partial learning of the 12 geometric figures came at intervals of 7, 10, 12, 13, 11, 11, and 17 days. Relearning following the seventh memory

test was 81 days removed from the original learning (Table I). The learning, memory test, and relearning scores for each subject are given in Table XI. According to this table, Subject 3 learned all 12 of the geometric figures while Subject 21 learned only 5. On the first memory test Subject 3 recalled only 7, or just over half of the geometric figures he had learned, and Subject 21 recalled 4, or 80 per cent of the number he had learned. Subject 14, who learned at an average speed, learned 67 per cent of the geometric figures and, on the first memory test, recalled 38 per cent of these.

The scores in Table XI, read from left to right, indicate the relation between retention and speed of learning for each individual. When read from top to bottom, they show the relation of the 21 subjects to one another on both retention and speed of learning.

TABLE XI. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 12 GEOMETRIC FIGURES IN PARTIAL LEARNING

SUBJECT	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
3	12	7	8	7	4	7	6	9	12
11	11	8	4	5	3	6	5	6	12
19	11	8	12	12	7	10	9	12	12
1	10	9	12	12	7	8	10	10	12
2	9	3	3	5	2	3	4	4	11
5	9	4	7	5	4	3	6	5	9
8	9	0	1	3	2	3	3	2	6
10	9	6	4	3	6	6	6	3	11
16	9	4	5	6	7	6	9	8	12
4	8	1	1	1	2	2	2	3	9
7	8	5	3	3	3	4	3	3	8
9	8	5	6	7	4	3	4	3	9
12	8	7	6	4	6	5	5	6	11
14	8	3	1	2	2	5	4	2	7
17	8	4	4	3	3	3	3	3	10
20	8	5	3	4	5	5	4	4	10
13	7	1	1	2	2	2	2	3	10
15	7	2	1	2	1	2	2	2	9
18	6	3	2	0	1	3	3	1	10
6	5	4	2	2	2	2	2	1	4
21	5	4	1	2	3	4	2	2	8

The memory test scores, expressed in percentages, are shown in graphical form in Figure 13. The shape of the bars shows no definite trend. A few of the groups are bell-shaped, but a number are so irregular that they conform to no definite pattern. However, when the bars as a whole are examined, they show that there is a tendency for the fast learners to remember more of what they learned than for the slow learners to do so.

The changes in rank of each subject are shown in Table XII. Subject 3, who ranked 1 in speed of learning, ranked 4.5, 3, 3.5, 8, 3, 5, and 3 on the seven memory tests, and 3 in relearning. Subject 21 who ranked lowest (20.5) in speed of learning, ranked 12, 18.5, 17, 11.5, 10.5, 19, and 17.5 on the memory tests, and 17.5 on relearning. The fact that the subjects maintained a relatively constant ranking in learning, memory test, and relearning scores is proof that there is a rather close relation between the speed with which these geometric figures are learned and the ability to recall them.

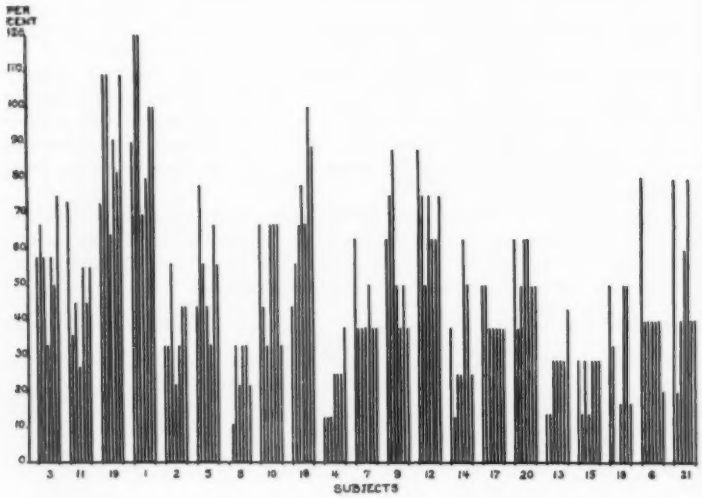

Fig. 13. Efficiency of Recall on the 12 Geometric Figures in Partial Learning.

TABLE XII. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 12 GEOMETRIC FIGURES IN PARTIAL LEARNING

Subject	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
3	1	4.5	3	3.5	8	3	5	3	3
11	2.5	2.5	9	7	11.5	5	7.5	5.5	3
19	2.5	2.5	1.5	1.5	2	1	2.5	1	3
1	4.	1	1.5	1.5	2	2	1	2	3
2	7	16	12	7	16.5	14.5	10.5	8.5	7
5	7	12	4	7	8	14.5	5	7	14.5
8	7	21	18.5	12.5	16.5	14.5	14.5	17.5	20
10	7	6	9	12.5	4.5	5	5	12.5	7
16	7	12	7	5	2	5	2.5	4	3
4	13	19.5	18.5	20	16.5	19.5	19	12.5	14.5
7	13	8	12	12.5	11.5	10.5	14.5	12.5	17.5
9	13	8	5.5	3.5	8	14.5	10.5	12.5	14.5
12	13	4.5	5.5	9.5	4.5	8	7.5	5.5	7
14	13	16	18.5	17	16.5	8	10.5	17.5	19
17	13	12	9	12.5	11.5	14.5	14.5	12.5	10.5
20	13	8	12	9.5	6	8	10.5	8.5	10.5
13	17.5	19.5	18.5	17	16.5	19.5	19	12.5	10.5
15	17.5	18	18.5	17	20.5	19.5	19	17.5	14.5
18	19	16	14.5	21	20.5	14.5	14.5	20.5	10.5
6	20.5	12	14.5	17	16.5	19.5	19	20.5	21
21	20.5	12	18.5	17	11.5	10.5	19	17.5	17.5
Correlation		.56	.71	.82	.61	.74	.84	.80	.70
$P.E._r$		±.11	±.08	±.05	±.10	±.07	±.04	±.05	±.08

The correlations between the learning scores and the memory and relearning scores (Table XII) substantiate the conclusion that those who learn these figures rapidly tend to remember more than those who learn slowly. The lowest correlation (+.56) is between learning scores

and the first memory test and the highest (+.84) between learning and the sixth memory test.

The average learning, memory test, and relearning scores for the upper, middle, and lower thirds of the group are given in Table XIII. The upper third learned an average of 10.1 figures; the middle third, 8.3; and the lower third, 6.6. On all memory tests, except the fourth, the upper third recalled a higher percentage of what it had learned than did either the middle or the lower third.

The comparison between retention and speed of learning in the three groups is shown more clearly in Figure 14, which is expressed in percentages. On all except the fourth memory test, the curve for

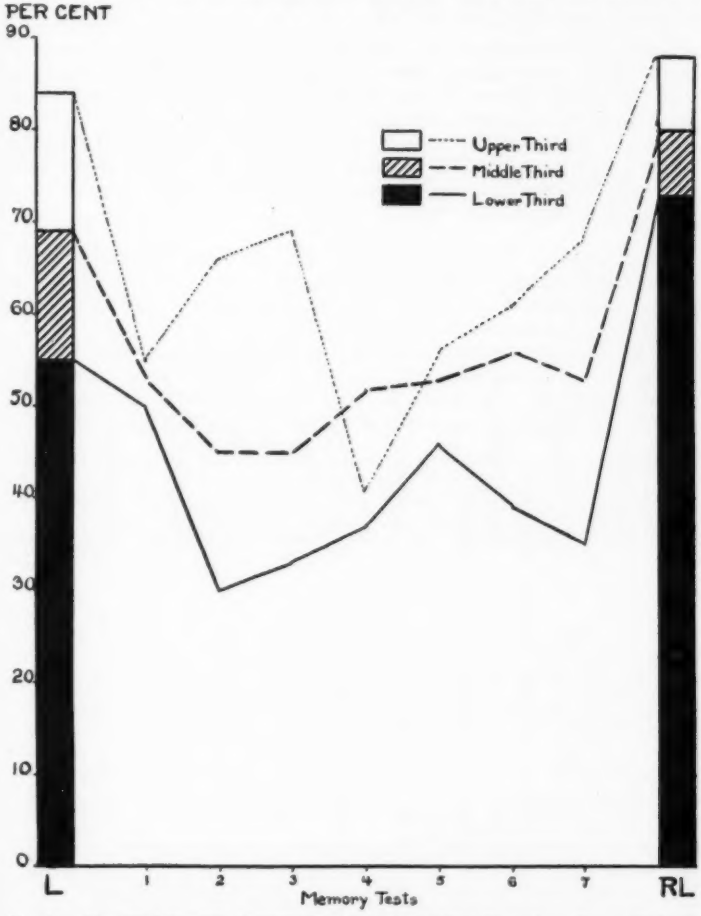

Fig. 14. Average Learning, Memory Test, and Relearning Percentage Scores Made by Each Third of the Group on the 12 Geometric Figures in Partial Learning.

the upper third is above that of the middle and lower groups; and for all seven memory tests except the first the curves of the upper and middle thirds are well above the curve for the lower third.

TABLE XIII. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 12 GEOMETRIC FIGURES IN PARTIAL LEARNING

SUBJECT	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
Upper third	10.1	5.6	6.7	7.0	4.1	5.7	6.1	6.9	10.6
Middle third	8.3	4.4	3.7	3.7	4.3	4.4	4.7	4.0	9.6
Lower third	6.6	3.3	2.0	2.1	2.4	3.0	2.6	2.3	8.7

There is little difference between the three groups in retention as measured by relearning, and speed of learning (Table XIII). The fact that the bars in Figure 14 are nearly the same height shows that the three groups were approximately equal in relearning.

An evaluation of all the data concerning the learning and retention of the 12 geometric figures indicates that there is a tendency for those who learn rapidly to remember more of what they learn than do those who learn more slowly.

5. Symbols. The seven memory tests following the partial learning of the 60 symbols came at intervals of 7, 14, 12, 14, 10, 13, and 14 days. Relearning following the seventh memory test was 84 days removed from the original learning (Table I).

The learning, memory test, and relearning scores made by each subject are given in Table XIV. Subject 1 learned all 60 of the symbols, while Subject 21 learned but 13. On the first memory test Subject 1 recalled 41 of the 60 symbols and Subject 21 recalled but 3 of the 13

TABLE XIV. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 60 SYMBOLS IN PARTIAL LEARNING

SUBJECT	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
1	60	41	30	33	22	28	19	21	56
8	58	5	2	3	7	7	6	3	30
3	57	21	14	20	17	20	14	22	60
11	57	18	22	19	13	10	7	11	60
10	54	29	28	24	23	22	23	22	55
19	53	32	28	30	18	18	19	26	56
16	49	29	28	25	27	25	25	30	59
2	47	14	16	16	12	12	13	16	56
12	47	14	19	11	17	13	12	17	57
15	47	17	19	18	19	17	15	22	50
5	45	7	6	6	6	7	5	6	32
18	44	28	24	24	17	13	18	16	49
4	43	9	5	6	4	5	2	5	31
9	43	16	17	14	8	6	9	10	43
13	41	16	20	20	18	19	20	19	43
14	36	4	5	7	7	5	5	5	18
7	35	22	13	14	12	15	7	7	26
6	33	4	5	4	4	4	3	4	26
20	27	7	6	5	5	7	7	7	23
17	25	17	12	16	19	8	8	14	26
21	13	3	2	2	3	4	2	4	13

symbols he had learned. Subject 18, who learned at average speed, learned 44 of the 60 symbols and recalled 28 of them on the first memory test.

The scores in Table XIV, when read from left to right, show the relation between retention and speed of learning for each individual. When read from top to bottom, they show the relation of the 21 subjects to one another in both speed of learning and retention of symbols.

The memory test scores, expressed in percentages, are shown in graphical form in Figure 15. The shape of the individual memory curves is quite irregular, probably the most common being a somewhat inverted bell-shaped curve. Some subjects remembered a higher percentage of what they had learned on the first memory test; others remembered most on memory tests further removed from learning. On the whole, the shape of the bars seems to indicate that those who learned fastest recalled more of the symbols learned. There are, however, cases where rapid learners recalled very little of what they had learned, just as there are slow learners who recalled a higher percentage of the symbols.

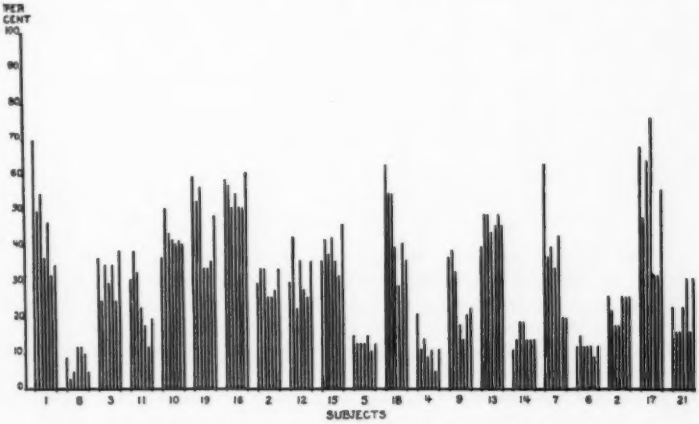

Fig. 15. Efficiency of Recall on the 60 Symbols in Partial Learning.

The changes in rank of each subject are given in Table XV. Subject 1, who ranked 1 in speed of learning, ranked 1, 1, 1, 3, 1, 4.5, and 6 on the seven memory tests, and 6 in relearning. Subject 21 ranked 21 in speed of learning, 21, 20.5, 21, 21, 20.5, 20.5, and 19.5 on the seven memory tests, and 21 in relearning. Subject 5, who learned at an average speed, ranked 11 in speed of learning; 16.5, 15.5, 16.5, 17, 15, 17.5, and 16 on the seven memory tests; and 13 in relearning. The tendency for the subject to maintain a relatively constant rank in speed of learning and in recall and relearning indicates that there is a positive relation between the speed of learning 60 symbols and the ability to recall them later. The contention that there is a tendency for those who learn rapidly to recall more of the symbols they had learned than the less rapid learners is in part substantiated by the correlations of speed

of learning scores with memory and relearning scores. The correlations range from +.51 between speed of learning and the sixth memory test to +.81 between speed of learning and relearning. These correlations are all sufficiently high to be significant.

TABLE XV. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 60 SYMBOLS IN PARTIAL LEARNING

SUBJECT	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
1	1	1	1	1	3	1	4.5	6	6
5	2	18	20.5	20	15.5	15	16	21	15
3	3.5	6	12	6.5	9	4	8	4	1.5
11	3.5	8	6	8	11	12	14	12	1.5
10	5	7	3	4.5	2	3	2	4	8
19	6	2	3	2	6.5	6	4.5	2	6
16	7	3	3	3	1	2	1	1	3
2	9	13.5	11	10.5	12.5	11	9	9.5	6
12	9	13.5	8.5	14	9	9.5	10	8	4
15	9	9.5	8.5	9	4.5	7	7	4	9
8	11	16.5	15.5	16.5	17	15	17.5	16	13
18	12	4	5	4.5	9	9.5	6	9.5	10
4	13.5	15	18	16.5	19.5	18.5	20.5	17.5	14
9	13.5	11.5	10	12.5	14	17	11	13	11.5
13	15	11.5	7	6.5	6.5	5	3	7	11.5
14	16	19.5	18	15	15.5	18.5	17.5	17.5	20
7	17	5	13	12.5	12.5	8	14	14.5	17
6	18	19.5	18	19	19.5	20.5	19	19.5	17
20	19	16.5	15.5	18	18	15	14	14.5	19
17	20	9.5	14	10.5	4.5	13	12	11	17
21	21	21	20.5	21	21	20.5	20.5	19.5	21
Correlation		.55	.59	.57	.53	.63	.51	.54	.81
P.E.$_r$		±.11	±.10	±.11	±.11	±.09	±.11	±.11	±.05

The average learning, memory test, and relearning scores for the upper, middle, and lower thirds of the group are given in Table XVI. The upper group learned faster than the middle third and almost twice as fast as the lower group. On the first memory test, however, the upper third recalled an average of 23.7 symbols; the middle group, 15.0; and the lower group, 10.4.

The relation between retention and speed of learning for the three groups is shown in Figure 16, which is based on percentages. It will be noted that the three curves are not widely separated on any test, but that on all memory tests except the fourth and sixth the curve representing the upper group is above that of either the middle or lower third. There is a tendency for the lower group to remember more of the symbols it had learned than for the middle third. In Figure 16 retention as measured by relearning scores may be compared with speed of learning.

TABLE XVI. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 60 SYMBOLS IN PARTIAL LEARNING

SUBJECT	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
Upper third	55.4	23.7	21.7	22.0	18.1	18.6	16.1	19.3	53.7
Middle third	45.1	15.0	15.1	13.6	11.9	10.4	10.6	13.1	45.4
Lower third	30.0	10.4	9.0	9.7	9.7	8.9	7.4	8.6	25.0

A study of all the data concerning the relation between the speed of learning the 60 symbols and the ability to recall them later indicates that there is a tendency for those who learn the most rapidly to remember more of what they learned.

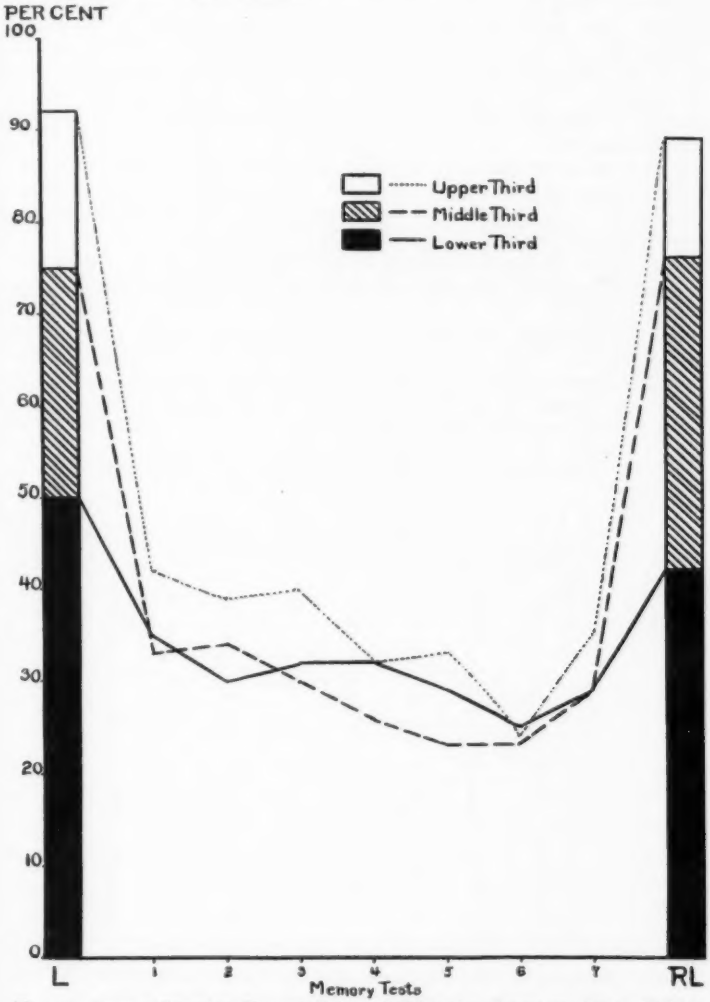

Fig. 16. Average Learning, Memory Test, and Relearning Percentage Scores Made by Each Third of the Group on the 60 Symbols in Partial Learning.

6. Poetry. The seven memory tests following the partial learning of the stanza of poetry came at intervals of 7, 14, 12, 10, 13, 12, and 14 days. Relearning following the seventh memory test was 82 days removed from the original learning (Table I).

The learning, memory test, and relearning scores made by each subject are given in Table XVII. The range of learning scores is from 38 to 96, one point being given for each of the 110 words in the stanza of poetry that was memorized in the study of partial learning. Subject 3 learned 96 of the words and Subject 21 learned 38. Thus, Subject 3 learned more than twice as much poetry during the time given as did Subject 21. On the first memory test Subject 3 recalled 35 of the words, or 36 per cent of what he had learned, and Subject 21 recalled 4 words, or 11 per cent of what he had learned. On the first memory test Subject 15, with a learning score of 63, recalled 30 words (48 per cent of what he had learned).

The scores in Table XVII, when read from left to right, show the relation between retention and speed of learning for each individual. When read from top to bottom, they show the relation of the 21 subjects to one another in both retention and speed of learning.

The memory scores, expressed in percentages, are shown in graphical form in Figure 17. The predominant shape of the individual memory curves is linear. There is a very definite tendency for the subjects to recall approximately the same amount of the poetry on each of the seven memory tests. When the bars as a group are examined, their contour is slightly bell-shaped, which indicates that those subjects who learned at average speed tended to recall more of what they had learned than did either the rapid or slow learners.

TABLE XVII. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE STANZA OF POETRY IN PARTIAL LEARNING

Subject	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
3	96	35	34	32	50	29	12	28	96
8	94	3	7	14	13	13	13	13	57
6	85	22	26	30	24	24	25	26	104
2	81	7	7	7	7	11	7	13	66
9	78	2	7	12	9	9	8	9	42
4	77	14	49	38	16	14	14	30	78
1	76	2	12	12	12	13	11	14	37
5	76	0	6	6	8	6	7	8	38
19	71	16	14	12	14	13	14	13	23
11	68	18	16	13	18	15	18	14	47
15	63	30	28	30	41	41	31	46	84
10	59	6	8	9	8	8	8	8	38
12	55	0	14	14	14	13	14	14	48
7	53	7	3	4	1	2	0	10	26
13	51	0	12	12	12	12	12	13	37
18	50	6	11	11	9	11	13	9	50
16	49	3	4	7	13	14	14	14	56
20	45	2	1	1	1	1	2	6	32
14	41	8	0	4	10	10	9	10	32
17	39	0	0	12	14	12	15	14	31
21	38	4	14	7	11	9	0	4	37

The changes in rank for each subject are given in Table XVIII. Subject 3, who ranked 1 in speed of learning, ranked 1, 2, 3, 1, 2, 11.5, and 3 on the seven memory tests, and 2 in relearning. Subject 21, who ranked 21 in speed of learning, ranked 12, 7, 16, 13, 16.5, 20 5, and 21 on the seven memory tests, and 15 in relearning. Subject 15, however, who learned at an average speed, ranked 2, 3, 1, 2, 1, 1, and 2 on the

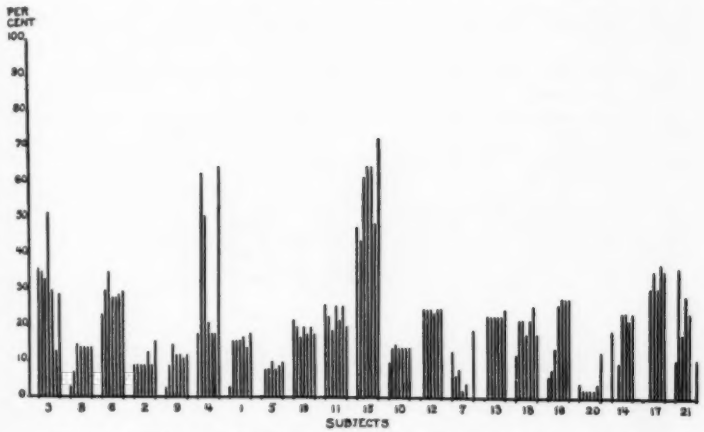

Fig. 17. Efficiency of Recall on the Stanza of Poetry in Partial Learning.

TABLE XVIII. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE STANZA OF POETRY IN PARTIAL LEARNING

SUBJECT	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
3	1	1	2	3	1	2	11.5	3	2
8	2	13.5	14	5.5	9.5	8.5	9.5	11.5	6
6	3	3	4	4	3	3	2	4	1
2	4	8.5	14	16	19	13.5	17.5	11.5	5
9	5	16	14	10	15.5	16.5	15.5	16.5	11
4	6	6	1	2	5	5.5	6.5	1	4
1	7.5	16	9.5	10	11.5	8.5	13	7	15
5	7.5	19.5	16	18	17.5	19	17.5	18.5	12.5
19	9	5	7	10	7	8.5	6.5	11.5	21
11	10	4	5	7	4	4	3	7	10
15	11	2	3	1	2	1	1	2	3
10	12	10.5	12	14	17.5	18	15.5	18.5	12.5
12	13	19.5	7	5.5	7	8.5	6.5	7	9
7	14	8.5	18	19.5	20.5	20	20.5	14.5	20
13	15	19.5	9.5	10	11.5	11.5	11.5	11.5	15
18	16	10.5	11	13	15.5	13.5	9.5	16.5	8
16	17	13.5	17	16	9.5	5.5	6.5	7	7
20	18	16	19	21	20.5	21	19	20	17.5
14	19	7	20.5	19.5	14	15	14	14.5	17.5
17	20	19.5	20.5	10	7	11.5	4	7	19
21	21	12	7	16	13	16.5	20.5	21	15
Correlation		.34	.50	.57	.31	.45	.17	.43	.62
$P.E._r$		±.14	±.11	±.10	±.14	±.12	±.15	±.13	±.10

seven memory tests, and 3 in relearning. According to Table XVIII, the subject who learned at an average speed tended to maintain a more constant ranking than did either the rapid or slow learner. This would indicate that there was some, but not a close, relation between speed of learning the stanza of poetry and the ability to recall later what was learned.

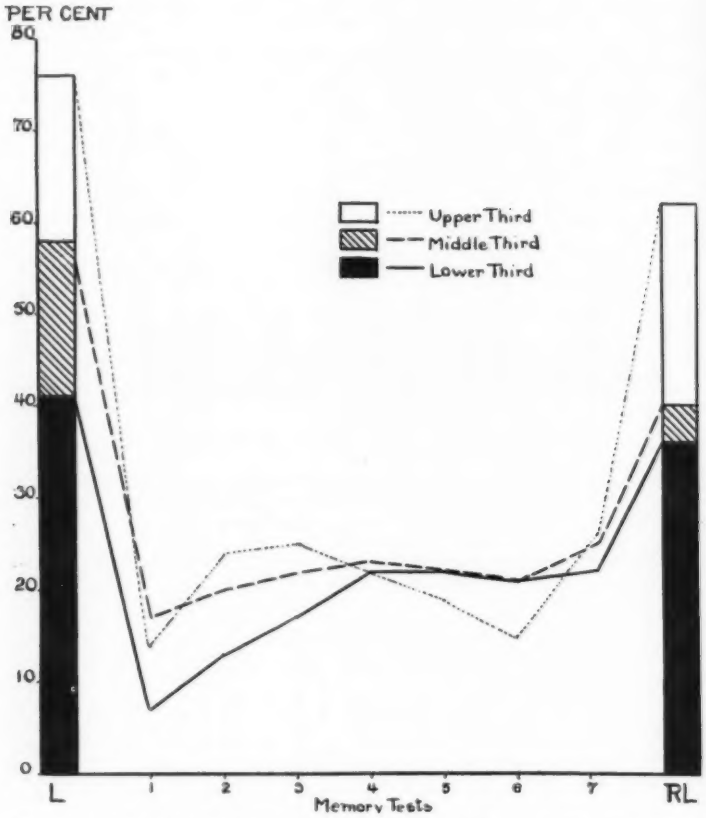

Fig. 18. Average Learning, Memory Test, and Relearning Percentage Scores Made by Each Third of the Group on the Stanza of Poetry in Partial Learning.

The correlations (Table XVIII) of the learning scores with the memory and relearning scores substantiate the conclusion that there was a positive relation between the speed of learning the stanza of poetry and the ability to recall it later. The lowest correlation (+.17) is between speed of learning and the sixth memory test, and the highest (+.62) is between speed of learning and the relearning trial. Considering the size of the P.E.'s the correlations are only sufficiently high to show a trend in the relationship. They do not constitute conclusive evidence.

The average learning, memory test, and relearning scores for the upper, middle, and lower thirds of the group are given in Table XIX. The upper third learned an average of 83.9 words; the middle group, 63.6 words; and the lower third, 44.7 words. On the first memory test, however, the middle group recalled a slightly higher percentage of the

poetry it had learned than did the upper third and more than twice as much as the lower third.

A comparison between retention and speed of learning for the three groups is shown in Figure 18, which is based on percentages. The three curves are close together on all seven memory tests but show a slight tendency for the middle group to remember more of what it had learned. According to this figure, there was a slight tendency for the fast learners to excel in relearning.

An evaluation of all the data concerning the relation between retention of poetry and speed of learning indicates that there is little positive relation between the two. The tendency for the rapid learners to remember more of what they had learned is so small as to be almost insignificant.

TABLE XIX. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE STANZA OF POETRY IN PARTIAL LEARNING

SUBJECT	Learning trial	First memory test	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Relearning trial
Upper third	83.9	12.1	20.3	20.7	18.7	16.1	12.9	21.9	68.6
Middle third	63.6	11.0	12.7	13.9	14.9	14.0	13.1	16.1	43.4
Lower third	44.7	3.3	6.0	7.7	10.0	9.9	9.3	10.0	39.3

Conclusions. Some of the more important results of the investigation of the relation of retention to speed of learning in partial learning are:

1. The degree of relation between retention and speed of learning is in part determined by:
   (1) The learning material.
   (2) The method of measuring retention.
   (3) The treatment of the data.
2. Retention as measured by recall shows that:
   (1) For names and dates, geometric figures, and symbols rapid learners recalled more of what they learned than did slow learners.
   (2) For nonsense syllables and poetry there was a tendency for rapid learners to recall more of what they learned than for slow learners.
   (3) For words there was but little evidence of a positive relation between retention and speed of learning.
   (4) The recall of nonsense syllables and names and dates tended to be more efficient approximately 40 days after learning than it was either earlier or later.
   (5) There was no one period of time after learning for which recall was most efficient for words, geometric figures, symbols, and poetry.
3. When the subjects were divided into three groups on the basis of their speed of learning:
   (1) There was a tendency for the group consisting of those subjects

who learned fastest to be more efficient in recall of words, geometric figures, and symbols.

(2) There was a tendency for the group consisting of those subjects who learned at an average speed to be more efficient in recall of nonsense syllables and poetry.

(3) There was little difference between the groups of rapid, average, and slow learners in efficiency of recall of names and dates.

(4) Retention, when measured by the speed of relearning, shows a significantly high positive correlation between speed of learning and relearning. The correlations between speed of learning with memory tests and speed of relearning are given in Table XX. Conclusions based on these correlations may be criticized, however, because of (1) the simplicity of the learning material, (2) the homogeneity of the learning ability of the subjects, and (3) the large number of tied ranks.

TABLE XX. CORRELATIONS OF SPEED OF LEARNING WITH MEMORY TESTS AND SPEED OF RELEARNING IN PARTIAL LEARNING

Test Material	First memory test		Second memory test		Third memory test		Fourth memory test		Fifth memory test		Sixth memory test		Seventh memory test		Relearning trials	
	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r
Nonsense syllables	.49	.12	.35	.13	.49	.12	.54	.11	.27	.14	.50	.12	.45	.12	.69	.08
Words	.35	.14	.08	.15	-.02	.15	.18	.15	.46	.12	.47	.12	.31	.14	.51	.11
Names and dates	.82	.05	.76	.06	.73	.07	.79	.05	.80	.05	.69	.08	.73	.07	.81	.05
Geometric figures	.56	.11	.71	.08	.82	.05	.61	.10	.74	.07	.84	.04	.80	.05	.70	.08
Symbols	.55	.11	.59	.10	.57	.11	.53	.11	.63	.09	.51	.11	.54	.11	.81	.05
Poetry	.34	.14	.50	.11	.57	.10	.31	.14	.45	.12	.17	.15	.43	.13	.62	.10

4. Efficiency of retention, when measured by a comparison of the raw group scores in learning with relearning, shows that:

(1) On nonsense syllables, words, geometric figures, and poetry the group of subjects who learned slowest relearned more in relation to its original scores than either the upper or middle groups.

(2) On names and dates and symbols the three groups were approximately equal in amount relearned as compared with their original learning. The group of subjects who learned at average speed, however, was slightly more efficient than either the upper or lower group. The average learning and relearning scores and the difference between these scores for each of the three groups for each type of learning material are given in Table XXI.

Conclusions based on the differences between raw scores may be criticized, however, because (1) the upper group had less to relearn, (2) the increase made by a subject who had a low score is probably not directly comparable with a similar increase made by a student who had a high score, (3) the amount to be learned was limited, and therefore continued relearning trials would eventually equalize the relearning scores for the three groups, and (4) since the subjects were divided into

TABLE XXI. AVERAGE LEARNING AND RELEARNING SCORES AND DIFFERENCE BETWEEN THESE SCORES MADE BY EACH THIRD OF THE GROUP IN PARTIAL LEARNING

	Learning	Relearning	Difference
NONSENSE SYLLABLES—			
Upper	13.0	13.1	0.1
Middle	11.0	12.6	1.6
Lower	6.7	9.4	2.7
WORDS—			
Upper	21.4	17.3	−4.1
Middle	14.4	9.0	−5.4
Lower	10.1	11.4	1.3
NAMES AND DATES—			
Upper	22.7	22.7	0.0
Middle	18.0	21.0	3.0
Lower	11.9	12.4	0.5
GEOMETRIC FIGURES—			
Upper	10.1	10.6	0.5
Middle	8.3	9.6	1.3
Lower	6.6	8.7	2.1
SYMBOLS—			
Upper	55.4	53.7	−1.7
Middle	45.1	45.4	0.3
Lower	30.0	25.0	−5.0
POETRY—			
Upper	83.9	68.6	−15.3
Middle	63.6	43.4	−20.2
Lower	44.7	39.3	−5.4

three groups that were as nearly equal in number as possible, there were cases in which students of the same rank fell in different thirds of the group.

II. Complete Learning

In complete learning, speed of learning was measured by the number of trials required by each subject to make one accurate written reproduction of the material being learned. Retention was measured by the scores made on each memory test and the number of trials required to relearn the material to one accurate reproduction. For ease of presentation and interpretation, the data concerning complete learning are presented in the same order and the tables are of the same types as were used in the discussion of partial learning. The first figure in the discussion of each type of material is also the same in complete learning as in partial learning, the percentages being based on the total amount to be learned. A second figure has been inserted, giving the number of learning and relearning trials of each subject. Average memory scores for each third of the group are shown, expressed in percentages, in a third figure and are presented in the same form as the average memory test scores in partial learning. Percentages for each memory test are also computed on the basis of the total amount to be learned.

1. Nonsense Syllables. The seven memory tests following the complete learning of the 15 nonsense syllables came at intervals of 7, 26, 21, 11, 10, 24, and 24 days. The 15 nonsense syllables were relearned three times: (1) the first relearning, which followed the first memory test,

took place 7 days after the original learning; (2) the second relearning, which followed the sixth memory test, came 99 days after the original learning and 92 days after the first relearning; and (3) the third relearning, which followed the seventh memory test, took place 123 days after the original learning, 116 days after the first relearning, and 24 days after the second relearning (Table I).

The number of learning trials required by each subject to produce one correct written reproduction of the 15 nonsense syllables, the seven memory test scores, and the number of trials required by each subject on each of the three relearning trials are given in Table XXII. The range of learning trials is from 3 to 10. Subjects 1 and 2 learned the 15 nonsense syllables in 3 trials; Subject 21 required 10. In relation to speed of learning, Subjects 1 and 2 learned more than three times as fast as Subject 21. On the first memory test Subject 1 recalled 14, or 93 per cent of the 15 syllables he had learned, while Subject 2, who learned at the same speed as Subject 1, recalled 3 of the syllables, or 20 per cent of those he had learned. Subject 21, the slowest learner of the 21 subjects, recalled 3 of the syllables, which was exactly the number recalled by Subject 2, one of the two most rapid learners. Subject 12, who learned at an average speed, recalled 11 syllables, or 73 per cent, on the first memory test. On the first relearning, however, Subjects 1, 2, and 12 relearned the syllables with 1 trial each, while Subject 21 required 4 trials.

TABLE XXII. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 15 NONSENSE SYLLABLES IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
1	3	14	1	2	11	12	12	11	1	14	1
2	3	3	1	8	4	4	5	4	3	7	2
7	4	7	2	9	4	4	8	4	7	5	1
8	4	1	1	0	0	0	1	0	5	2	1
10	4	10	2	10	11	6	5	6	2	9	2
11	4	10	1	2	1	0	0	1	1	1	3
3	5	3	2	7	4	4	6	4	3	5	1
12	5	11	1	9	8	8	11	7	2	4	2
14	5	5	2	2	7	6	5	8	3	2	2
15	5	4	1	6	0	1	1	0	8	9	2
16	5	2	2	5	3	0	3	0	4	1	4
18	5	0	2	14	13	10	14	13	1	12	2
22	5	1	2	3	2	4	1	2	2	3	1
5	6	0	3	1	1	1	3	1	2	3	4
13	6	5	1	6	8	8	7	8	3	11	1
19	6	2	1	11	12	11	13	9	2	14	1
4	7	14	1	5	6	6	10	9	1	15	0
6	8	0	2	2	2	2	3	2	3	3	2
20	8	3	3	6	7	3	5	2	2	7	4
21	10	3	4	2	4	2	2	1	11	4	4

The scores in Table XXII, when read from left to right, show the relation between retention and speed of learning for each individual. When read from top to bottom, they show the relation of the 20 subjects to each other in retention and speed of learning.

The memory test scores, expressed in percentages, are shown in graphical form in Figure 19. The individual memory curves are very irregular in shape and no particular shape of curve predominates. The contour of the bars as a whole is quite irregular but approaches a linear curve. Some rapid learners were very efficient in recall; others were not. Similarly, some of the slowest learners recalled a high percentage of the nonsense syllables and others were quite inefficient. There is a slight tendency for retention to be more efficient on the memory test following the first and second relearnings. A study of the relation between retention, as measured by the number of trials required to relearn the 15 nonsense syllables, and speed of learning shows no convincing evidence that fast learners relearn more rapidly than slow learners.

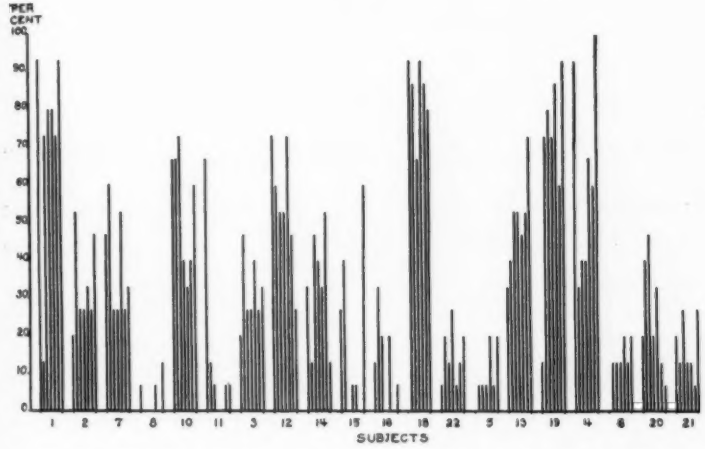

Fig. 19. Efficiency of Recall on the 15 Nonsense Syllables in Complete Learning.

A comparison of the number of learning trials with the number of relearning trials shows great individual variations in the relation between the two. The curves in Figure 20, however, indicate that there is a tendency on the first and third relearnings for the rapid learners to learn faster than the slow learners. There seems to be little, if any, difference between the rapid and slow learners in speed of relearning on the second relearning.

The changes in rank of each subject are shown in Table XXIII. Subject 1, who was one of the most rapid learners, ranked 1.5, 16, 3.5, 1, 3, 2, and 2.5 on the seven memory tests, and 5, 2.5, and 5 on the three relearning trials. Subject 2, another of the rapid learners, ranked 11.5, 6, 11.5, 10.5, 10.5, 10, and 8.5 on the seven memory tests, and 5, 13, and 12 on the three relearnings. Subject 21, who was the slowest learner of the 20 subjects, ranked 11.5 on the first memory test and 16, 11.5, 14.5, 16, 16, and 12.5 on the other six. On the first and second relearnings he ranked 20, and on the third, 18.5. Subject 18, who ranked 10 in speed of

learning, ranked 19, 1, 1, 3, 1, 1, and 4 on the seven memory tests, and 13.5, 2.5, and 12 in relearning. The fact that the subjects did not maintain a relatively constant ranking in speed of learning and recall indicates that there is little relation between the speed of learning 15 nonsense syllables and the ability to recall or relearn them later.

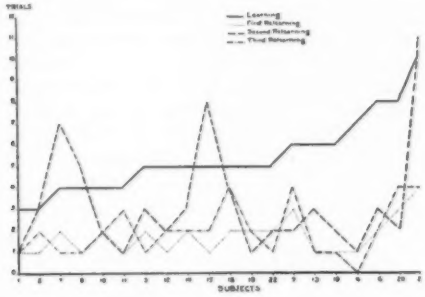

Fig. 20. Number of Trials Required by Each Subject in Learning and Relearning the 15 Nonsense Syllables in Complete Learning.

TABLE XXIII. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 15 NONSENSE SYLLABLES IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
1	1.5	1.5	5	16	3.5	1	3	2	2.5	2.5	5
2	1.5	11.5	5	6	11.5	10.5	10.5	10	13	8.5	12
7	4.5	6	13.5	4.5	11.5	10.5	6	10	18	10.5	5
8	4.5	16.5	5	20	19.5	19	18	19	17	17.5	5
10	4.5	4.5	13.5	3	3.5	7	10.5	8	7.5	6.5	12
11	4.5	4.5	5	16	17.5	19	20	16	2.5	19.5	16
3	10	11.5	13.5	7	11.5	10.5	8	10	13	10.5	5
12	10	3	5	4.5	5.5	4.5	4	7	7.5	12.5	12
14	10	7.5	13.5	16	7.5	7	10.5	5.5	13	17.5	12
15	10	9	5	9	19.5	16.5	18	19	19	6.5	12
16	10	14.5	13.5	11.5	14	19	14	19	16	19.5	18.5
18	10	19	13.5	1	1	3	1	1	2.5	4	12
22	10	16.5	13.5	13	15.5	10.5	18	13	7.5	15	5
5	15	19	18.5	19	17.5	16.5	14	16	7.5	15	18.5
13	15	7.5	5	9	5.5	4.5	7	5.5	13	5	5
19	15	14.5	5	2	2	2	2	3.5	7.5	2.5	5
4	17	1.5	5	11.5	9	7	5	3.5	2.5	1	1
6	18.5	19	13.5	16	15.5	14.5	14	13	13	15	12
20	18.5	11.5	18.5	9	7.5	13	10.5	13	7.5	8.5	18.5
21	20	11.5	20	16	11.5	14.5	16	16	20	12.5	18.5
Correlation		.35	.51	.16	.00	.09	.03	.08	.13	-.04	.31
P.E.$_r$		±.14	±.12	±.15	±.16	±.16	±.22	±.16	±.16	±.16	±.15

Further evidence of the lack of any significant relation between retention and speed of learning the 15 nonsense syllables is provided by the low correlations (Table XXIII) of speed of learning with recall and relearning. The only correlation which is high enough to show any tendency is that between speed of learning and the first relearning, which is .51±.12.

The average number of trials required to learn the syllables, the average memory scores, and the average number of trials required for relearning for the upper, middle, and lower thirds of the group are given in Table XXIV. The upper third required 1.1 fewer trials to learn the 15 nonsense syllables than the middle group and 3.4 fewer trials than the lower third. The middle group required 2.3 fewer trials than the lower third. Although the lower third recalled .1 words more than the middle third and 3.0 words fewer than the upper third on the first memory test, on the seventh memory test it recalled far more than either of the other groups.

TABLE XXIV. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 15 NONSENSE SYLLABLES IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
Upper third	3.9	6.9	1.4	5.4	5.0	4.3	5.3	4.3	3.1	6.1	1.6
Middle third	5.0	3.8	1.7	6.5	5.5	4.8	5.8	5.0	3.3	5.2	2.2
Lower third	7.3	3.9	2.1	4.7	5.7	4.7	6.1	4.6	3.4	8.1	2.3

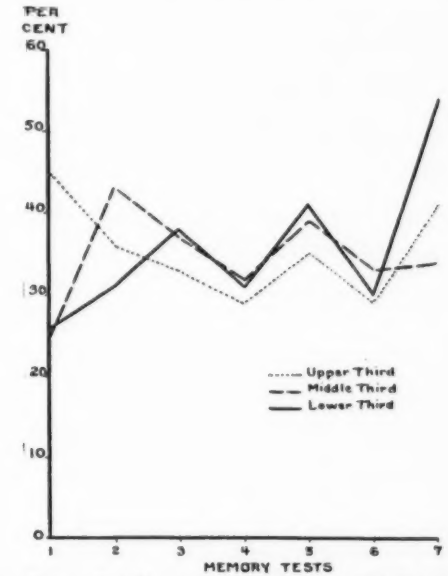

Fig. 21. Average Memory Test Percentage Scores Made by Each Third of the Group on the 15 Nonsense Syllables in Complete Learning.

The relation between retention and speed of learning for the three groups may be more easily studied by examining the curves in Figure 21, which are based on percentages. This, like Table XXIV, shows that the lower third recalled more than the upper third on all but the first two memory tests, and the middle third recalled more than the upper third on all tests except the first and last. The three curves follow each other rather closely.

An evaluation of all the data concerning the relation between the ability to learn a list of 15 nonsense syllables and recall and relearn them later indicates that there is little, if any, relation between retention and speed of learning.

2. Words. The seven memory tests following the complete learning of the 25 words came at intervals of 7, 20, 28, 20, 15, 12, and 30 days. The first relearning came 7 days after the original learning; the second 102 days after learning and 95 days after the first relearning; and the third 132 days after learning, 125 days after the first relearning, and 30 days after the second relearning (Table I).

The number of learning trials required by each subject to learn the 25 words, the seven memory test scores, and the number of trials required for each relearning are given in Table XXV. The number of learning trials ranges from 5 to 9. Subjects 10 and 23 learned the 25 words in 5 trials, while Subjects 2 and 9 required 9 trials, or twice as many. On the first memory test Subject 10 recalled 18; Subject 23, 22; Subject 2, only 9; and Subject 9, 18 of the words. For the first relearning, Subjects 10, 23, and 9 relearned in 1 trial each, and Subject 2 in 2 trials.

When the scores in Table XXV are read from left to right, they show the relation between retention and speed of learning for each individual. When read from top to bottom, they show comparisons between individuals.

TABLE XXV. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 25 WORDS IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
10	5	18	1	10	18	21	19	21	1	21	1
23	5	22	1	12	22	24	23	18	1	9	1
1	6	23	1	10	8	17	9	12	2	21	1
3	6	14	1	11	10	8	9	6	3	15	1
5	6	15	2	4	15	17	18	21	1	25	0
7	6	8	1	16	18	19	23	25	0	25	0
8	6	2	4	9	12	8	12	7	1	11	2
12	6	13	2	11	11	15	13	17	1	13	3
14	7	9	4	4	14	8	7	15	3	3	3
15	7	3	1	13	20	20	23	21	1	19	1
16	7	3	2	12	14	18	23	25	0	22	1
18	7	21	1	14	17	12	21	16	2	23	3
4	8	21	1	21	20	23	25	23	1	23	1
11	8	6	2	6	7	6	3	6	2	4	2
13	8	22	1	15	18	17	13	13	2	17	2
24	8	13	1	7	7	6	5	25	3	16	2
2	9	9	2	18	8	4	10	17	1	11	2
9	9	18	1	8	9	9	12	10	1	12	2

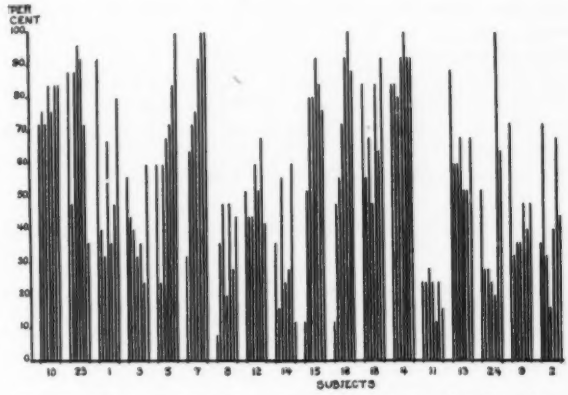

Fig. 22. Efficiency of Recall on the 25 Words in Complete Learning.

The memory test scores, expressed in percentages are shown in graphical form in Figure 22. The individual bars show no definite trend in the shape of the memory curves. The majority of the curves are quite irregular in shape. When the bars as a whole are examined, the resulting curve approaches a straight line, indicating that the slow learners were as efficient in recall as were the rapid learners.

The relation between retention, as measured by the number of trials required to relearn, and speed of learning is shown in Figure 23. The trend of these curves indicates that the slow learners were approximately as efficient in relearning as were the fast learners.

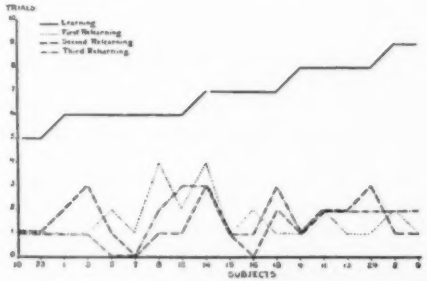

Fig. 23. Number of Trials Required by Each Subject in Learning and Relearning the 25 Words in Complete Learning.

The changes in rank of each subject are given in Table XXVI. Subject 10, who was one of the two fastest learners, ranked 1.5 in speed of learning, and 6.5, 2, 4.5, 3, 7, 6, and 6 on the seven memory tests; and Subject 23, who also ranked 1.5 in speed of learning, ranked 2.5, 8.5, 1, 1, 3.5, 8, and 16 on the seven memory tests. Both of these subjects ranked 6, 7, and 6 on the three relearning trials. Subject 2, one

of the two slowest learners, ranked 12.5, 3, 15.5, 18, 13, 9.5, and 14.5 on the memory tests, and 14, 7, and 12.5 on the relearnings. Subject 9, who also ranked 17.5 in speed of learning, ranked 6.5, 14, 14, 12, 11.5, 15, and 13 on the memory tests, and 6, 7, and 12.5 on the relearnings. The rankings indicate that there is little relation between the speed of learning 25 words and ability to recall or relearn them later. The correlations of speed of learning with memory test scores and speed of relearning are not sufficiently high to be significant.

TABLE XXVI. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 25 WORDS IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
10	1.5	6.5	6	2	4.5	3	7	6	7	6	6
23	1.5	2.5	6	8.5	1	1	3.5	8	7	16	6
1	5.5	1	6	12	15.5	8	14.5	14	13.5	7	6
3	5.5	9	6	10.5	13	13	14.5	17.5	17	11	6
5	5.5	8	14	17.5	7.5	8	8	6	7	1.5	1.5
7	5.5	14	6	4	4.5	5	3.5	2	1.5	1.5	1.5
8	5.5	18	17.5	13	11	17	11.5	16	7	14.5	12.5
12	5.5	10.5	14	10.5	12	10	9.5	9.5	7	12	17
14	10.5	12.5	17.5	17.5	9.5	15	16	12	17	18	17
15	10.5	16.5	6	7	2.5	4	3.5	6	7	8	6
16	10.5	16.5	14	8.5	9.5	6	3.5	2	1.5	5	6
18	10.5	4.5	6	6	6	11	6	11	13.5	3.5	17
4	14.5	4.5	6	1	2.5	2	1	4	7	3.5	6
11	14.5	15	14	16	17.5	15	18	17.5	13.5	17	12.5
13	14.5	2.5	6	5	7.5	8	9.5	13	13.5	9	12.5
24	14.5	10.5	6	15	17.5	15	17	2	17	10	12.5
2	17.5	12.5	14	3	15.5	18	13	9.5	7	14.5	12.5
9	17.5	6.5	6	14	14	12	11.5	15	7	13	12.5
Correlation...		.14	.19	.04	.45	.47	.30	.12	.28	.22	.49
$P.E._r$.....		±.16	±.16	±.17	±.13	±.13	±.16	±.17	±.16	±.16	±.12

The average number of trials required to learn the 25 words, the average memory test scores, and the average number of trials required to relearn for the upper, middle, and lower thirds of the group are given in Table XXVII. The upper group learned in one trial fewer than the middle group and in 2.6 fewer trials than the lower third. On the first memory test the upper third was most efficient in recall, reproducing 16.7 words, while the lower third learned 14.8 and the middle group 8.5. The number of trials needed by the first and third groups on the first relearning was nearly the same, but the middle group required 1 full trial more than either of them.

The relation between retention and speed of learning for the three groups is shown in Figure 24, which is based on percentages. These curves show that there is a tendency for the upper and middle groups to be more efficient in recall than the lower group, but the difference is not great enough to be convincing evidence that rapid learners are more efficient in recall than slow learners.

An evaluation of all the data concerning the speed of learning 25 words and the ability to recall and relearn them later offers no convincing

evidence that fast learners recall more or relearn more rapidly than slow learners.

TABLE XXVII. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 25 WORDS IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
Upper third	5.7	16.7	1.2	12.0	15.2	17.7	16.8	17.2	1.3	19.2	0.7
Middle third	6.7	8.5	2.3	10.5	14.7	12.7	16.5	16.8	1.3	15.2	2.2
Lower third	8.3	14.8	1.3	12.5	11.0	10.8	11.3	15.7	1.7	13.8	1.8

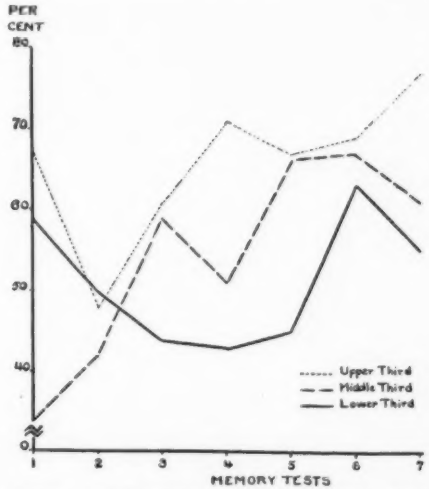

Fig. 24. Average Memory Test Percentage Scores Made by Each Third of the Group on the 25 Words in Complete Learning.

3. Names and Dates. The seven memory tests following the complete learning of the 19 names and dates in complete learning came at intervals of 7, 21, 14, 20, 11, 12, and 36 days. The first relearning, following the first memory test, was 7 days removed from the original learning; the second relearning, following the sixth memory test, came 85 days after the original learning and 78 days after the first relearning; and the third relearning, following the seventh memory test, was 121 days removed from the original learning, 114 days after the first relearning, and 36 days after the second relearning (Table I).

The number of learning trials, the seven memory test scores, and the number of relearning trials required by each subject are given in Table XXVIII. The range of learning trials is from 3 to 9. Subjects 1, 7, and 23 learned the names and dates in 3 trials each, while Subject 11 re-

quired 9 trials, or three times as many. On the first memory test Subject 1 recalled 17 of the names and dates, Subject 7 recalled 12, and Subject 23 recalled 8. Subject 11, who was the slowest learner of the 18 subjects, recalled 5 of the names and dates. Subject 4, who learned at an average speed, recalled 17 of the names and dates on the first memory test. On the first relearning all five of these subjects relearned the 19 names and dates in 1 learning trial.

TABLE XXVIII. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 19 NAMES AND DATES IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
1	3	17	1	19	19	19	19	17	1	17	1
7	3	12	1	14	13	17	19	19	0	16	1
23	3	8	1	16	18	18	15	17	1	17	1
2	4	11	1	15	15	13	15	19	0	17	1
3	4	7	1	13	8	12	9	8	2	11	1
22	4	10	2	9	7	8	9	14	1	12	1
5	5	7	2	9	8	13	8	15	1	11	1
6	5	13	1	13	13	14	13	13	1	13	1
10	5	18	1	17	14	17	17	17	1	16	2
13	5	9	1	12	14	11	11	13	3	12	1
16	5	17	1	16	12	14	15	19	0	12	1
4	6	17	1	13	12	18	10	17	1	19	0
9	6	17	2	4	6	4	6	14	1	12	2
12	6	17	2	12	15	12	15	19	0	13	1
15	6	17	1	11	13	13	15	17	1	17	1
18	7	16	2	17	17	19	19	19	0	17	2
19	7	19	0	13	19	17	17	19	0	15	1
11	9	5	1	7	9	5	3	8	1	6	2

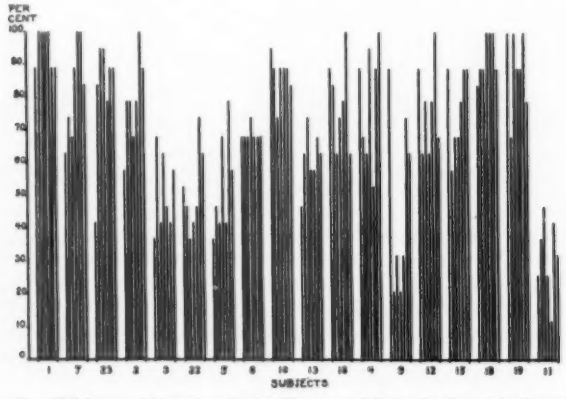

Fig. 25. Efficiency of Recall on the 19 Names and Dates in Complete Learning.

The scores in Table XXVIII, when read from left to right, show the relation between retention and speed of learning for each subject. When read from top to bottom, they show the relation of the 18 subjects to each other in both retention and speed of learning.

The memory test scores, expressed in percentages, are shown in graphical form in Figure 25. Again there is no definite trend in the shape of the individual memory curves. There seems, however, to be a slight predominance of the bell-shaped curves indicating that recall was more efficient for those subjects an interval of time after learning than it was either nearer or further removed from the original learning. The contour of the bars as a whole is not regular, but approaches a slightly negatively accelerated linear curve. This indicates there is a slight tendency for the rapid learners to recall more of the names and dates than do the slow learners.

The relation between retention as measured by the number of trials required to relearn and the speed of learning the 19 names and dates is shown in Figure 26. The relearning curves do not follow the shape of the learning curve. The curves for the first and second relearnings are practically straight lines, which fact shows that the slow learners relearned just as rapidly as the fast learners. The fact that the curve for the third relearning is slightly positively accelerated indicates that the slow learners tend to relearn less rapidly than the fast learners. The trend is so slight that there is little evidence that rapid relearning is more closely associated with rapid learning than it is with slow learning.

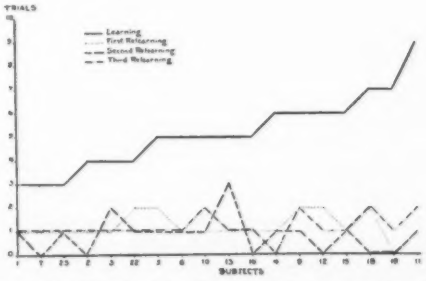

Fig. 26. Number of Trials Required by Each Subject in Learning and Relearning the 19 Names and Dates in Complete Learning.

The changes in rank of each subject are shown in Table XXIX. Subject 1, who was one of the three most rapid learners, ranked 5.5, 1, 1.5, 1.5, 2, 9, and 4 on the seven memory tests. On the relearnings he ranked 7.5, 11.5, and 8. Subject 7, another of the rapid learners, ranked 11, 7, 10, 6, 2, 3.5, and 7.5 on the seven memory tests, and 7.5, 3.5, and 8 on the three relearnings. Subject 11, the slowest learner in the group, ranked 18, 17, 14, 17, 18, 17.5, and 18 on the seven memory tests, and 7.5, 11.5, and 16.5 on relearning. A study of the rankings in Table XXIX shows that there is little evidence that the rapid learners remembered more of the names and dates than did the slow learners.

Further evidence of the lack of any significant relation between the retention of the 19 names and dates and the speed at which they were learned is shown by the correlations in Table XXIX. The highest correlation, .53±.12, is between speed of learning and the third relearning;

the lowest, $-.25 \pm .15$, between speed of learning and the first memory test. All of the correlations, with the possible exception of the one for the third relearning, are too low to be significant.

TABLE XXIX. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 19 NAMES AND DATES IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
1	2	5.5	7.5	1	1.5	1.5	2	9	11.5	4	8
7	2	11	7.5	7	10	6	2	3.5	3.5	7.5	8
23	2	15	7.5	4.5	3	3.5	8	9	11.5	4	8
2	5	12	7.5	6	5.5	11	8	3.5	3.5	4	8
3	5	16.5	7.5	9.5	15.5	13.5	14.5	17.5	17	16.5	8
22	5	13	16	15.5	17	16	14.5	13.5	11.5	13.5	8
5	9	16.5	16	15.5	15.5	11	16	12	11.5	16.5	8
6	9	10	7.5	9.5	10	8.5	11	15.5	11.5	10.5	8
10	9	2	7.5	2.5	7.5	6	4.5	9	11.5	7.5	16.5
13	9	14	7.5	12.5	7.5	15	12	15.5	18	13.5	8
16	9	5.5	7.5	4.5	12.5	8.5	8	3.5	3.5	13.5	8
4	13.5	5.5	7.5	9.5	12.5	3.5	13	9	11.5	1	1
9	13.5	5.5	16	18	18	18	17	13.5	11.5	13.5	16.5
12	13.5	5.5	16	12.5	5.5	13.5	8	3.5	3.5	10.5	8
15	13.5	5.5	7.5	14	10	11	8	9	11.5	4	8
18	16.5	9	16	2.5	4	1.5	2	3.5	3.5	4	16.5
19	16.5	1	1	9.5	1.5	6	4.5	3.5	3.5	9	8
11	18	18	7.5	17	14	17	18	17.5	11.5	18	16.5
Correlation...		−.25	.27	.44	.10	.23	.26	.04	−.02	.17	.53
$P.E._r$.....		±.15	±.15	±.13	±.17	±.16	±.15	±.17	±.17	±.16	±.12

The average number of trials required to learn the 19 names and dates, the average memory scores, and the average number of trials for each relearning for the upper, middle, and lower thirds of the group are given in Table XXX. The lower third required 3.3 more trials to learn the names and dates than did the upper third and 1.6 more than the middle group. On the first memory test, however, the upper group recalled but 10.8 of the 19 names and dates, while the middle third recalled 13.5 and the lower group 15.2 On the second memory test the upper third was more efficient, recalling 14.3, or 75 per cent, of the names and dates, while the middle third recalled 13.3 and the lower group 10.7.

The relation between retention, as measured by the number of trials required to relearn, and speed of learning is shown in Figure 26. The trend of these curves shows that there is very little difference between the fast and slow learners.

The relation between retention and speed of learning is shown in Figure 27, which is based on percentages. The crossing and recrossing of the curves shows that the slow learners were just as efficient in recall as were the rapid learners. A comparison of the average number of trials required for each relearning (Table XXX) shows the middle and lower groups to be just as efficient in relearning as the upper group.

An evaluation of all the data shows no significant relation between the speed of learning 19 names and dates and the ability to recall and relearn them later.

TABLE XXX. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 19 NAMES AND DATES IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
Upper third	3.5	10.8	1.2	14.3	13.3	14.5	14.3	15.7	0.8	15.0	1.0
Middle third	5.2	13.5	1.2	13.3	12.2	14.5	12.3	15.7	1.2	13.8	1.0
Lower third	6.8	15.2	1.3	10.7	13.2	11.7	12.5	16.0	0.5	13.3	1.5

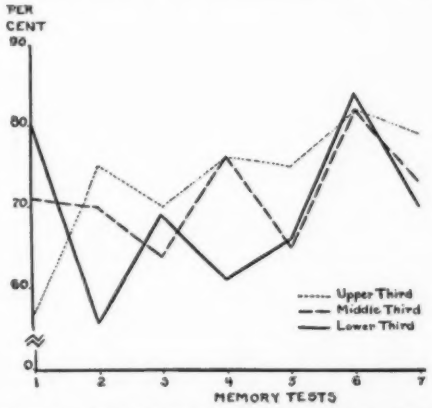

Fig. 27. Average Memory Test Percentage Scores Made by Each Third of the Group on the 19 Names and Dates in Complete Learning.

4. Geometric Figures. The seven memory tests following the complete learning of the 12 geometric figures came at intervals of 7, 21, 25, 13, 11, 21, and 10 days. The geometric figures were relearned three times; the first relearning came 7 days after the original learning; the second, 98 days after learning and 91 days after the first relearning; the third, 108 days after original learning, 101 days after the first relearning, and 10 days after the second relearning (Table I).

The number of learning trials, the seven memory test scores, and the number of relearning trials are given in Table XXXI. The number of learning trials ranges from 5 to 12. Five subjects, 3, 10, 11, 15, and 16, learned the geometric figures in 5 trials each; and 2 subjects, 7 and 13, required 12 trials each. There was considerable variation in the amount recalled by the five fastest learners on the first memory test. Subject 16 recalled 11 of the 12 figures, Subjects 3 and 15 recalled 10 each, Subject 11 recalled 9, and Subject 10 recalled only 5. One of the two slowest learners, Subject 13, recalled all of the geometric figures, and the other, Subject 7, recalled 10. A comparison of the number of trials needed by each subject on the first relearning shows the relation of speed of learning to retention to be negative, as the fast learners required more relearning trials than did the slow learners.

TABLE XXXI. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 12 GEOMETRIC FIGURES IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
3	5	10	3	10	10	9	10	9	1	10	1
10	5	5	3	9	9	11	11	9	1	8	4
11	5	9	1	10	11	11	11	10	1	11	1
15	5	10	2	8	6	7	7	9	3	10	1
16	5	11	1	11	11	12	10	11	1	11	2
1	6	11	1	9	8	10	11	10	1	10	2
9	6	9	2	8	7	9	10	12	0	12	0
14	6	11	1	9	10	11	11	11	1	10	2
8	7	10	3	8	8	7	7	9	1	9	3
2	8	11	1	9	11	11	12	12	0	11	1
4	8	12	0	9	9	9	10	10	1	8	1
12	8	10	2	10	8	9	9	10	1	10	1
18	8	12	0	10	11	11	10	10	1	9	1
19	8	11	2	11	12	11	10	12	0	12	0
20	8	7	3	12	9	9	7	9	5	9	2
21	8	9	2	9	8	9	10	10	1	10	2
22	8	11	1	11	11	11	10	10	1	7	2
5	9	11	1	10	12	12	12	12	0	12	0
17	9	8	3	6	9	9	7	9	1	9	3
6	10	11	1	7	9	11	10	10	1	11	1
7	12	10	1	9	5	6	9	7	1	10	2
13	12	12	0	10	11	11	11	10	1	11	1

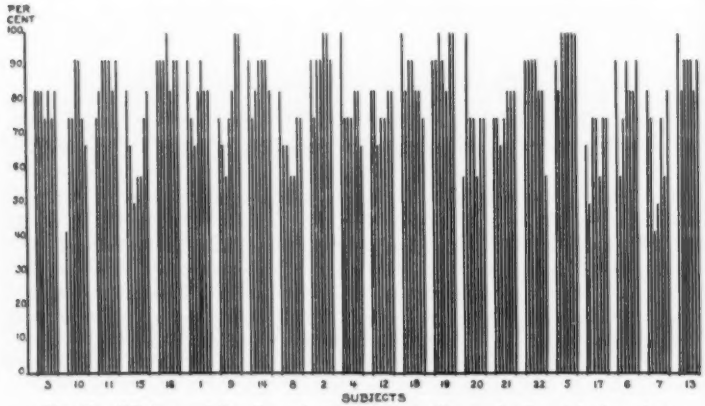

Fig. 28. Efficiency of Recall on the 12 Geometric Figures in Complete Learning.

The scores in Table XXXI, when read from left to right, show the relation between retention and speed of learning for each individual. When read from top to bottom, they show the relation of the 22 subjects to one another in both retention and speed of learning.

The memory test scores, expressed in percentages, are shown in graphical form in Figure 28. The individual bars have a slight tendency toward flatness, but many of them are so irregular that they conform to no definite shape. As a whole, however, the bars form a linear curve.

Slow learners were just as efficient in recall as were fast learners. This is true, also, in relearning (Table XXXI).

The changes in rank of each subject are given in Table XXXII. Subject 3, who was one of the five fastest learners, ranked 14, 7.5, 9.5, 16, 12, 18.5, and 12 on the seven memory tests, and 20, 12.5, and 8 on the three relearnings. Subject 19, who learned at an average speed, ranked 7.5, 3, 1.5, 7, 12, 2.5, and 2 on the seven memory tests, and 15, 2.5, and 2 in speed of relearning. Subject 7, one of the two slowest learners, was fairly consistent in falling in the group of those who learned more slowly and retained less than the average, but for the most part the rankings show little tendency for the subjects to maintain

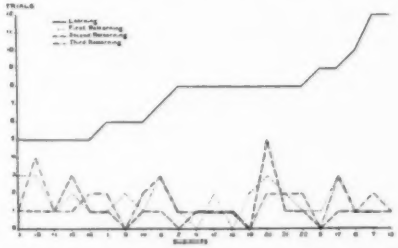

Fig. 29. Number of Trials Required by Each Subject in Learning and Relearning the 12 Geometric Figures in Complete Learning.

TABLE XXXII. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 12 GEOMETRIC FIGURES IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
3	3	14	20	7.5	9.5	16	12	18.5	12.5	12	8
10	3	22	20	14	13	7	5	18.5	12.5	20.5	22
11	3	18	8	7.5	5.5	7	5	11	12.5	6	8
15	3	14	15	19	21	20.5	20.5	18.5	21	12	8
16	3	7.5	8	3	5.5	1.5	12	5.5	12.5	6	16
1	7	7.5	8	14	17.5	12	5	11	12.5	12	16
9	7	18	15	19	20	16	12	2.5	2.5	2	2
14	7	7.5	8	14	9.5	7	5	5.5	12.5	12	16
8	9	14	20	19	17.5	20.5	20.5	18.5	12.5	17.5	20.5
2	13.5	7.5	8	14	5.5	7	1.5	2.5	2.5	6	8
4	13.5	2	2	14	13	16	12	11	12.5	20.5	8
12	13.5	14	15	7.5	17.5	16	17.5	11	12.5	12	8
18	13.5	2	2	7.5	5.5	7	12	11	12.5	17.5	8
19	13.5	7.5	15	3	1.5	7	12	2.5	2.5	2	2
20	13.5	21	20	1	13	16	20.5	18.5	22	17.5	16
21	13.5	18	15	14	17.5	16	12	11	12.5	12	16
22	13.5	7.5	8	3	5.5	7	12	11	12.5	22	16
5	18.5	7.5	8	7.5	1.5	1.5	1.5	2.5	2.5	2	2
17	18.5	20	20	22	13	16	20.5	18.5	12.5	17.5	20.5
6	20	7.5	8	21	13	7	12	11	12.5	6	8
7	21.5	14	8	14	22	22	17.5	22	12.5	12	16
13	21.5	2	2	7.5	5.5	7	5	11	12.5	6	8
Correlation...		−.23	−.23	.10	−.03	.09	.16	.06	.10	−.01	−.03
P.E.$_r$.....		±.13	±.13	±.15	±.15	±.15	±.15	±.15	±.15	±.15	±.15

a relatively constant position. An examination of the correlations (Table XXXII) of speed of learning with memory scores and relearning is further evidence of the lack of relation between retention and speed of learning. The correlations are not sufficiently high to indicate any definite trend.

The relation between retention, as measured by the number of trials required to relearn, and speed of learning is shown in Figure 29. Again, there is very little difference in number of trials required by the fast and slow learners.

The average number of trials required to learn the 12 geometric figures, the average memory scores, and the average number of trials required for each relearning for the upper, middle, and lower thirds of the group are given in Table XXXIII. The upper third required 2.3 fewer trials than the middle third and 4.4 fewer than the lower third to learn the geometric figures. On the memory tests, however, there was very little difference in the retention ability of the three groups, the total range being only from 8.9 to 10.5. The curves in Figure 30, which are based on percentages, show very definitely that there is no appreciable difference in efficiency of recall between the three groups. According to Table XXXIII, the lower third required fewer trials than either the upper or the middle groups on the first two relearnings. The difference, however, is too slight to be convincing evidence that the group of slow learners relearn geometric figures more rapidly than either the fast or the average learners.

TABLE XXXIII. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 12 GEOMETRIC FIGURES IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
Upper third	5.3	9.3	1.9	9.3	8.9	9.9	10.0	10.0	1.1	10.3	1.6
Middle third	7.6	10.5	1.5	9.8	9.8	9.8	9.5	10.4	1.3	9.8	1.4
Lower third	9.7	10.3	1.3	8.9	9.3	9.9	9.9	9.7	0.9	10.0	1.6

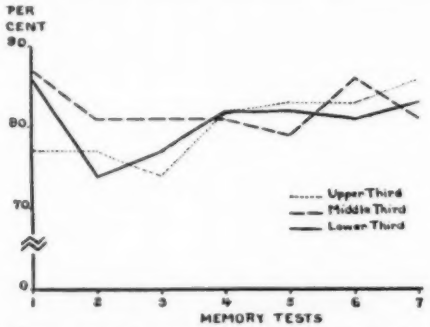

Fig. 30. Average Memory Test Percentage Scores Made by Each Third of the Group on the 12 Geometric Figures in Complete Learning.

An evaluation of all the data presented concerning the relation between the speed of learning 12 geometric figures and the ability to recall and relearn them later leads to the conclusion that there is little positive relation between speed of learning and retention.

5. Symbols. The seven memory tests following the complete learning of the 60 symbols came at intervals of 7, 22, 12, 11, 15, 11, and 30 days. The 60 symbols were relearned three times: the first relearning was 7 days removed from original learning; the second relearning was 78 days removed from learning and 71 days from the first relearning; and the third relearning came 108 days after original learning, 101 days after the first relearning, and 30 days after the second relearning (Table I).

The number of learning trials, the seven memory test scores, and the number of relearning trials required by each subject are given in Table XXXIV. The range of learning trials is from 7 to 15. Subject 2 learned the 60 symbols in 7 trials, while Subjects 19, 20, and 21 required 15 trials each. Thus, in relation to speed of learning, Subject 2 learned twice as rapidly as the slowest learners. On the first memory test Subject 2 recalled 45 of the 60 symbols; and Subjects 19, 20, and 21, who learned the symbols at the same speed, recalled 44, 29, and 45, respectively. Subject 8, who learned at an average speed, requiring 11 trials to learn the material, recalled 21 on the first memory test. On the first relearning, Subjects 2, 19, and 20 required but 1 trial each to reproduce the material, and Subjects 8 and 21 required 2 trials each.

When the scores in Table XXXIV are read from left to right, they show the relation between retention and speed of learning for each individual. When read from top to bottom, they show the relation of the 21 subjects to each other in retention and speed of learning.

TABLE XXXIV. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 60 SYMBOLS IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
2	7	45	1	43	45	54	50	53	2	50	2
3	8	45	1	43	53	52	54	54	2	53	1
1	9	55	1	56	55	58	60	56	1	60	0
11	9	41	1	23	21	19	33	38	2	27	1
14	9	44	2	27	39	50	49	58	1	38	3
4	10	41	2	46	39	43	48	45	3	35	2
10	10	42	1	29	30	31	33	32	2	34	1
16	10	39	1	15	36	44	42	46	1	54	1
6	11	26	3	30	30	32	34	32	3	41	4
7	11	7	1	26	23	41	26	22	4	51	1
8	11	21	2	19	22	24	25	43	2	48	2
5	12	55	1	37	41	40	52	55	1	56	2
9	12	44	1	31	41	50	37	41	2	33	2
15	12	44	1	34	42	40	45	51	4	58	1
17	12	36	1	37	44	39	45	35	3	50	1
18	12	53	1	57	60	58	59	60	0	59	1
12	13	44	1	53	43	47	43	41	1	46	2
13	13	35	1	46	48	48	57	54	2	60	0
19	15	44	1	39	50	58	58	60	0	57	1
20	15	29	1	17	24	32	20	29	3	22	2
21	15	45	2	33	25	25	17	12	3	26	2

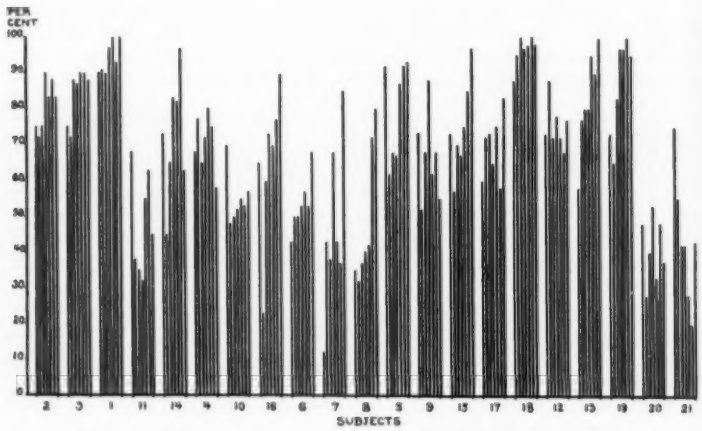

Fig. 31. Efficiency of Recall on the 60 Symbols in Complete Learning.

The memory test scores, expressed in percentages, are shown in graphical form in Figure 31. The individual bars, which are very irregular, show no definite trend in the shape of the memory curves. The contour of the bars as a whole is quite irregular but approaches a linear curve. Some rapid learners were very efficient in recall on all seven of the memory tests; others were no better than some of the slowest learners.

A study of the relation between retention, as measured by the number of trials required to relearn the 60 symbols, and speed of learning indicates that slow learners relearn just as rapidly as fast learners. A comparison of the number of trials required by each individual for each relearning with the number of trials required for learning shows great individual variation. There seem to be just as many cases of slow learners relearning rapidly as there are of rapid learners relearning slowly.

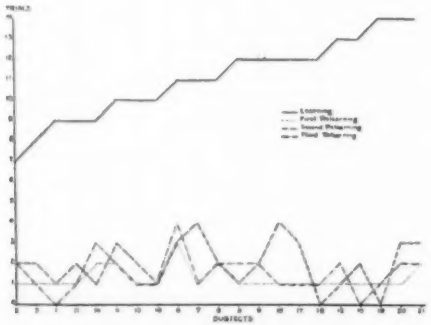

Fig. 32. Number of Trials Required by Each Subject in Learning and Relearning the 60 Symbols in Complete Learning.

The curves in Figure 32 show that there is no tendency for rapid learners to retain more than slow learners when retention is measured by relearning.

The changes in rank of each subject are given in Table XXXV. Subject 2, who learned the symbols fastest, ranked 5, 6.5, 6, 4, 7, 8, and 10.5 on the seven memory tests, and 8.5, 11, and 15.5 on the three relearning trials. Subject 21, one of the three slowest learners, ranked 20 in speed of learning, 5, 12, 17, 19, 21, 21, and 20 on the seven memory tests, and 18.5, 17, and 15.5 on the three relearnings. The fact that the subjects did not maintain a relatively constant ranking in speed of learning and recall indicates that there is little, if any, relation between retention and speed of learning.

The correlations (Table XXXV) of number of trials required to learn the 60 symbols with recall scores and number of trials required to relearn them provide further evidence that the speed of learning symbols and the ability to reproduce them later are not closely related. The highest correlation, $.21 \pm .15$, is between speed of learning and the sixth memory test; the lowest, $-.05 \pm .15$, is between the second memory test and speed of learning. None of the correlations are high enough to be significant.

TABLE XXXV. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 60 SYMBOLS IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
2	1	5	8.5	6.5	6	4	7	8	11	10.5	15.5
3	2	5	8.5	6.5	3	5	5	6.5	11	8	7
1	4	1.5	8.5	2	2	2	1	4	5	1.5	1.5
11	4	13.5	8.5	18	21	21	16.5	15	11	19	7
14	4	9	18.5	16	12.5	6.5	8	3	5	15	20
4	7	13.5	18.5	4.5	12.5	11	9	11	17	16	15.5
10	7	12	8.5	15	15.5	18	16.5	17.5	11	17	7
16	7	15	8.5	21	14	10	13	10	5	7	7
6	10	19	21	14	15.5	16.5	15	17.5	17	14	21
7	10	21	8.5	17	19	12	18	20	20.5	8	7
8	10	20	18.5	19	20	20	19	12	11	12	15.5
5	14	1.5	8.5	9.5	10.5	13.5	6	5	5	6	15.5
9	14	9	8.5	13	10.5	6.5	14	13.5	1	18	15.5
15	14	9	8.5	11	9	13.5	10.5	9	20.5	4	7
17	14	16	8.5	9.5	7	15	10.5	16	17	10.5	7
18	14	3	8.5	1	1	2	2	1.5	1.5	3	7
12	17.5	9	8.5	3	8	9	12	13.5	5	13	15.5
13	17.5	17	8.5	4.5	5	8	4	6.5	11	1.5	1.5
19	20	9	8.5	8	4	2	3	1.5	1.5	5	7
20	20	18	8.5	20	18	16.5	20	19	17	21	15.5
21	20	5	18.5	12	17	19	21	21	17	20	15.5
Correlation		.14	.19	−.05	.00	.16	.19	.21	.01	.03	.13
P.E.$_r$		±.15	±.15	±.15	±.15	±.15	±.15	±.15	±.15	±.15	±.15

The average number of trials required to learn the symbols, the average memory test scores, and the average number of trials required for each relearning by the upper, middle, and lower thirds are given in Table XXXVI. The upper third required 2.4 fewer learning trials than the middle third and 4.7 fewer than the lower third. On the first

memory test the upper and lower thirds both recalled considerably more than the middle third. The middle third recalled the smallest number of symbols on all except the last memory test.

The relation between retention and speed of learning for the three groups is shown in Figure 33, which is based on percentages. The curves for the three groups are not widely separated except on the second memory test. A comparison of the average number of trials required for each group for relearning (Table XXXVI) shows little difference between the three groups in speed of relearning.

An evaluation of all the data concerning the speed of learning symbols and the ability to recall them later shows no significant positive relation between retention and speed of learning.

TABLE XXXVI. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 60 SYMBOLS IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
Upper third	8.9	44.7	1.3	38.1	40.3	43.9	46.7	48.0	1.9	42.4	1.4
Middle third	11.3	33.7	1.4	27.4	33.6	38.7	37.3	41.4	2.4	48.7	1.9
Lower third	13.6	40.9	1.1	40.3	42.0	43.9	42.7	41.6	1.7	45.7	1.3

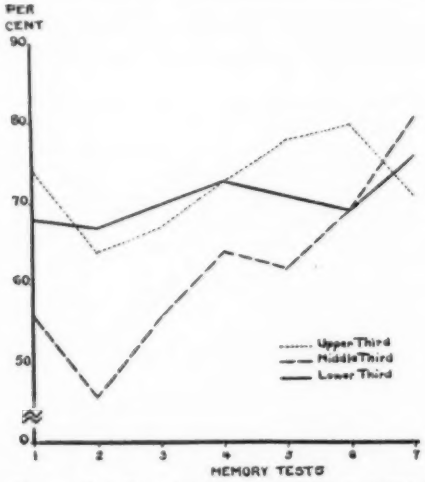

Fig. 33. Average Memory Test Percentage Scores Made by Each Third of the Group on the 60 Symbols in Complete Learning.

6. Poetry. The seven memory tests following the complete learning of the stanza of poetry came at intervals of 7, 20, 10, 10, 15, 11, and 28 days. The stanza of poetry used in complete learning contained 115 words. This stanza was relearned three times; the first relearning,

following the first memory test, took place 7 days after the original learning; the second relearning, following the sixth memory test, came 73 days after the original learning and 66 days after the first relearning; and the third relearning, following the seventh memory test, took place 101 days after the original learning, 94 days after the first relearning, and 28 days after the second relearning (Table I).

The number of learning trials required, the seven memory test scores, and the number of trials required by each subject to relearn the poetry in the three relearnings are given in Table XXXVII. The range of learning trials is from 8 to 14. Subjects 2 and 3 learned the stanza of poetry in 8 trials; Subject 7 required 14 trials, almost twice as many. On the first memory test Subject 2 recalled 76 of the 115 words in the stanza, Subject 3 recalled 77, and Subject 7 recalled only 26. On the first relearning Subjects 2 and 3 each required but 1 trial, while Subject 7 required 4 trials.

TABLE XXXVII. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE STANZA OF POETRY IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
2	8	76	1	99	87	97	94	99	1	110	1
3	8	77	1	65	66	83	92	90	2	109	1
1	9	46	2	112	113	113	114	115	0	112	2
6	9	57	2	80	99	97	101	101	1	106	2
8	9	12	3	61	37	49	72	36	2	64	2
9	9	53	2	55	66	64	57	61	5	72	2
16	9	88	1	76	97	106	103	105	2	107	1
5	10	40	2	53	18	26	30	29	2	40	1
10	10	81	1	102	99	98	91	100	3	115	0
11	10	62	2	29	76	72	67	77	1	100	1
14	10	59	2	90	90	90	75	93	1	78	1
19	10	43	3	95	99	101	100	103	1	115	0
20	10	105	4	99	101	97	93	96	2	96	2
4	11	58	1	113	112	114	113	115	0	115	0
12	11	105	2	107	108	106	105	107	1	111	1
13	11	18	3	46	54	54	55	54	1	47	1
15	11	71	2	113	114	113	114	115	0	115	0
17	12	36	3	85	87	87	84	87	1	86	1
18	12	103	1	101	90	104	87	104	2	104	2
21	13	17	3	28	13	36	49	19	3	78	2
7	14	26	4	54	10	45	38	22	5	31	3

The scores in Table XXXVII, when read from left to right, show the relation between retention and speed of learning for each individual. When read from top to bottom, they show the relation of the 21 subjects to each other in both retention and speed of learning.

The memory test scores, expressed in percentages, are shown in graphical form in Figure 34. A study of the individual bars shows considerable irregularity in the shape of the memory curves. There is, however, a predominance of linear curves. For many of the subjects efficiency of recall was relatively constant for the seven memory tests. The contour of the bars as a whole forms a somewhat trimodal curve. If the curve were smoothed, however, it would approach a linear curve.

The relation between retention as measured by the number of trials required to relearn the stanza of poetry and speed of learning

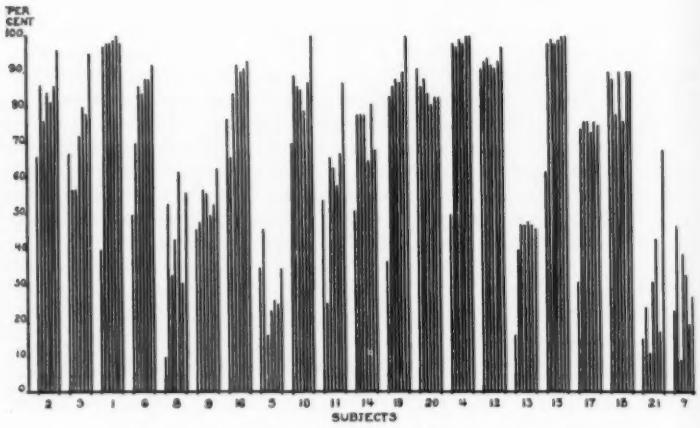

Fig. 34. Efficiency of Recall on the Stanza of Poetry in Complete Learning.

shows no evidence that the fast learners relearn more rapidly than the slow learners. The curves in Figure 35 show that on the first relearning there is a slight tendency for the rapid learners to relearn more rapidly than the slow learners, but on the second and third relearnings the slow learners relearned a little more rapidly than did the fast learners.

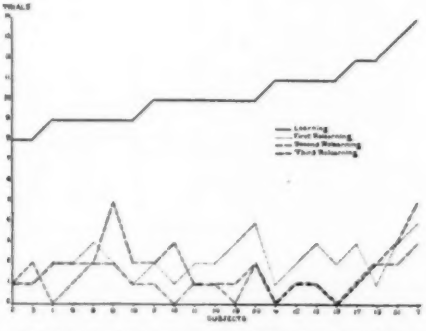

Fig. 35. Number of Trials Required by Each Subject in Learning and Relearning the Stanza of Poetry in Complete Learning.

The changes in rank of each subject are given in Table XXXVIII. Subject 2, who was one of the two fastest learners, ranking 1.5 in speed of learning, ranked 7, 7.5, 12.5, 10, 8, 10, and 7 on the seven memory tests, and 3.5, 7.5, and 9 on the three relearnings. Subject 3, who also ranked 1.5 in speed of learning, ranked 6, 14, 15.5, 14, 10, 13, and 8 on the seven memory tests, and 3.5, 14.5, and 9 on the three relearnings. Subject 7, the slowest of the 21 subjects in learning the stanza of poetry,

ranked 18, 17, 21, 19, 20, 20, and 21 on the seven memory tests, and 20.5, 20.5, and 21 on the three relearnings.

The fact that the subjects failed to maintain a relatively constant ranking in speed of learning, recall, and speed of relearning indicates that there is little, if any, positive relation between the speed of learning a 14-line stanza of poetry and the ability to recall it later.

Further evidence of the lack of any significant relation between the retention of poetry and speed of learning is given in the correlations in Table XXXVIII. The highest correlation (.46±.12) is between speed of learning and the first relearning; the lowest (.05±.15) is between the second memory test and speed of learning.

TABLE XXXVIII. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE STANZA OF POETRY IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
2	1.5	7	3.5	7.5	12.5	10	8	10	7.5	7	9
3	1.5	6	3.5	14	15.5	14	10	13	14.5	8	9
1	5	14	10.5	3	2	2.5	1.5	2	2	5	17
6	5	12	10.5	12	7	10	6	8	7.5	10	17
8	5	21	17	15	18	18	15	18	14.5	18	17
9	5	13	10.5	16	15.5	16	17	16	20.5	17	17
16	5	4	3.5	13	9	4.5	5	5	14.5	9	9
5	10.5	16	10.5	18	10	21	21	19	14.5	21	9
10	10.5	5	3.5	5	7	8	11	9	18.5	2.5	2.5
11	10.5	9	10.5	20	14	15	16	15	7.5	12	9
14	10.5	10	10.5	10	10.5	12	14	12	7.5	15.5	9
19	10.5	15	17	9	7	7	7	7	7.5	2.5	2.5
20	10.5	1.5	20.5	7.5	5	10	9	11	14.5	13	17
4	15.5	11	3.5	1.5	3	1	3	2	2	2.5	2.5
12	15.5	1.5	10.5	4	4	4.5	4	4	7.5	6	9
13	15.5	19	17	19	17	17	18	17	7.5	19	9
15	15.5	8	10.5	1.5	1	2.5	1.5	2	2	2.5	2.5
17	18.5	17	17	11	12.5	13	13	14	7.5	14	9
18	18.5	3	3.5	6	10.5	6	12	6	14.5	11	17
21	20	20	17	21	20	20	19	21	18.5	15.5	17
7	21	18	20.5	17	21	19	20	20	20.5	21	21
Correlation...		.25	.46	.05	.13	.09	.30	.16	.09	.21	.09
P.E.$_r$.....		±.14	±.12	±.15	±.15	±.15	±.14	±.15	±.15	±.14	±.15

The average number of trials required to learn the poetry, the average memory test scores, and the average number of trials required for each relearning by the upper, middle, and lower thirds of the group are given in Table XXXIX. The upper third required 1.4 fewer trials than the middle third and 3.3 fewer trials than the lower third to memorize the stanza of poetry. The middle third made the highest score on four of the memory tests and the upper third on the other three. The lower third was consistent in making the lowest scores. However, on the third relearning, the upper third required .2 more trials than the lower third.

The relation between retention and speed of learning for the three groups is shown clearly in Figure 36. The curves are close together for all seven memory tests. The curves for the upper and middle thirds are slightly above the curve for the lower third. There is no appreciable difference in efficiency of recall for the upper and middle thirds.

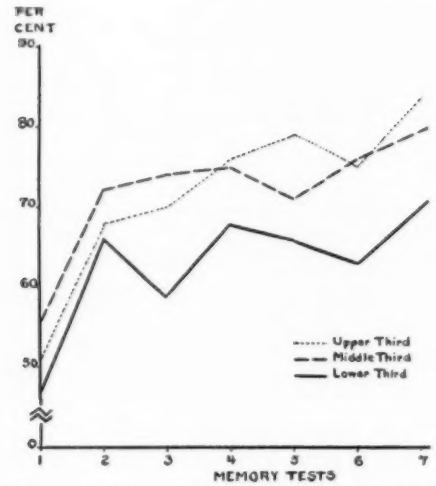

Fig. 36. Average Memory Test Percentage Scores Made by Each Third of the Group on the Stanza of Poetry in Complete Learning.

An evaluation of all the data concerning the relation between the ability to learn a 14-line stanza of poetry and to recall and relearn it later indicates that there is little, if any, positive relation between the two.

TABLE XXXIX. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE STANZA OF POETRY IN COMPLETE LEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Second relearning trial	Seventh memory test	Third relearning trial
Upper third	8.7	58.4	1.7	78.3	80.7	87.0	90.4	86.7	1.9	97.1	1.6
Middle third	10.1	64.0	2.1	83.0	85.0	85.4	81.3	87.6	1.4	94.1	0.7
Lower third	12.0	53.7	2.6	76.3	68.0	77.9	76.0	72.6	1.9	81.7	1.4

Conclusions. The major conclusions resulting from the study of the relation of retention to speed of learning in complete learning are as follows:

1. No significant positive relation was found between retention and speed of learning.
2. Although practically all of the correlation coefficients between speed of learning and memory test scores are positive and all correlation coefficients between speed of learning and relearning are positive, the correlations as a whole are too low to be significant. The few correlations which are sufficiently high to be significant are probably an incident of the experimental conditions. The correlations between speed of learning, memory test scores, and speed of relearning are given in Table XL.

Conclusions based on these correlations may be criticized, however, because of (1) the simplicity of the learning material, (2) the homogeneity of the learning ability of the subjects, and (3) the large number of tied ranks.

TABLE XL. CORRELATIONS OF SPEED OF LEARNING WITH MEMORY TESTS AND SPEED OF RELEARNING IN COMPLETE LEARNING

Test material	First memory test		First relearning trial		Second memory test		Third memory test		Fourth memory test		Fifth memory test		Sixth memory test		Second relearning trial		Seventh memory test		Third relearning trial	
	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r
Nonsense syllables	.35	.14	.51	.12	.16	.15	.00	.16	.09	.16	.03	.22	.08	.16	.13	.16	-.04	.16	.31	.15
Words	.15	.16	.19	.16	.04	.17	.45	.13	.47	.13	.30	.16	.12	.17	.28	.16	.22	.16	.49	.12
Names and dates	-.25	.15	.27	.15	.44	.13	.10	.17	.23	.16	.26	.15	.04	.17	-.02	.17	.17	.16	.53	.12
Geometric figures	-.23	.13	-.23	.13	.10	.15	-.03	.15	.09	.15	.16	.15	.06	.15	.10	.15	-.01	.15	-.03	.15
Symbols	.14	.15	.19	.15	-.05	.15	.00	.15	.16	.15	.19	.15	.21	.15	.01	.15	.03	.15	.13	.15
Poetry	.25	.14	.46	.12	.05	.15	.13	.15	.09	.15	.30	.14	.16	.15	.09	.15	.21	.14	.09	.15

3. When the average number of trials required to relearn are compared with the average number of learning trials for each group there is little evidence that the group of subjects who learned fastest relearned with significantly fewer trials than the groups of average or slow learners.

If, however, the comparisons are made on the basis of the number of trials saved in relearning, the lower third saved more trials in relearnings than did the upper or middle third. The average number of learning and relearning trials and the saving for the three groups for each type of learning material are given in Table XLI.

TABLE XLI. AVERAGE LEARNING AND RELEARNING SCORES AND DIFFERENCE BETWEEN THESE SCORES MADE BY EACH THIRD OF THE GROUP IN COMPLETE LEARNING

	Learning	First relearning	Difference	Second relearning	Difference	Third relearning	Difference
NONSENSE SYLLABLES—							
Upper	3.9	1.4	2.5	3.1	0.8	1.6	2.3
Middle	5.0	1.7	3.3	3.3	1.7	2.2	2.8
Lower	7.3	2.1	5.2	3.4	3.9	2.3	5.0
WORDS—							
Upper	5.7	1.2	4.5	1.3	4.4	0.7	5.0
Middle	6.7	2.3	4.4	1.3	5.4	2.2	4.5
Lower	8.3	1.3	7.0	1.7	6.6	1.8	6.5
NAMES AND DATES—							
Upper	3.5	1.2	2.3	0.8	2.7	1.0	2.5
Middle	5.2	1.2	4.0	1.2	4.0	1.0	4.2
Lower	6.8	1.3	5.5	0.5	6.3	1.5	5.3
GEOMETRIC FIGURES—							
Upper	5.3	1.9	3.4	1.1	4.2	1.6	3.7
Middle	7.6	1.5	6.1	1.3	6.3	1.4	6.2
Lower	9.7	1.3	8.4	0.9	8.8	1.6	8.1
SYMBOLS—							
Upper	8.9	1.3	7.6	1.9	7.0	1.4	7.5
Middle	11.3	1.4	9.9	2.4	8.9	1.9	9.4
Lower	13.6	1.1	12.5	1.7	11.9	1.3	12.3
POETRY—							
Upper	8.7	1.7	7.0	1.9	6.8	1.6	7.1
Middle	10.1	2.1	8.0	1.4	8.7	0.7	9.4
Lower	12.0	2.6	9.4	1.9	10.1	1.4	10.6

Conclusions based on the differences between number of trials required for learning and relearning may be criticized because (1) the upper group had less to relearn, (2) the reduction of one trial in relearning when many trials were required to learn is probably not directly comparable to a reduction of one trial when few were required to learn, (3) the amount to be learned was limited, and therefore continued relearning would eventually equalize the number of relearning trials for the three groups, and (4) since the subjects were divided into three groups that were as nearly equal in number as possible, there were cases in which students of the same rank fell in different thirds of the group.

III. Overlearning

Speed of learning was measured by the number of trials required by each subject to make two accurate, consecutive written reproductions of the material being learned. Retention was measured by the scores made on each memory test and by the number of trials required to relearn the materials to one accurate reproduction. The data concerning overlearning are presented in the same type of tables and graphs and the order of presentation of results is the same as for complete learning.

1. Nonsense Syllables. The seven memory tests following the overlearning of the 15 nonsense syllables came at intervals of 7, 9, 20, 7, 7, 9, and 4 days. The syllables were relearned three times: the first relearning, following the first memory test, came 7 days after the original learning; the second relearning, following the second memory test, took place 16 days after original learning and 9 days after the first relearning; and the third relearning, following the seventh memory test, came 63 days after original learning, 56 days after the first relearning, and 47 days after the second relearning (Table I).

The number of trials required by each subject to make two correct consecutive written reproductions of the 15 nonsense syllables, the seven memory test scores, and the number of trials required by each subject to relearn the material are given in Table XLII. The range of learning trials is from 4 to 12. Subject 1 learned the syllables in 4 trials, which was three times as fast as Subject 21, who required 12. On the first memory test Subject 1 recalled 3 nonsense syllables and Subject 21 recalled 2, while Subject 15, who required 6 trials to learn, recalled 14 of the syllables. On the first relearning, Subjects 1 and 15 required 2 trials each, and Subject 21, the slowest learner of the 21 subjects, required 6 trials.

When the scores in Table XLII are read from left to right they show the relation between retention and speed of learning for each individual. When read from top to bottom, they show the relation of the 21 subjects to one another in both retention and speed of learning.

The memory test scores, expressed in percentages, are shown in graphical form in Figure 37. The individual memory curves are quite irregular and there seems to be no trend toward a definite shape. The

contour of the bars as a whole is linear, which shows there is no tendency for rapid learners to be more efficient in recall than slow learners.

TABLE XLII. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 15 NONSENSE SYLLABLES IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
1	4	3	2	13	2	8	13	15	15	15	0
2	5	1	3	5	2	14	12	10	11	14	2
3	5	0	3	10	2	15	7	11	12	11	1
5	5	9	2	14	2	8	14	12	11	12	1
6	5	1	4	3	3	10	12	12	13	13	1
7	5	1	3	12	3	8	7	6	8	5	1
8	5	0	4	4	2	8	9	6	5	8	3
10	5	9	3	13	2	13	13	14	15	14	1
12	5	5	3	11	2	10	11	13	15	11	1
14	5	12	3	5	3	10	9	9	9	9	1
19	5	3	3	13	2	11	12	11	11	13	1
9	6	6	4	12	2	10	12	5	10	12	2
11	6	2	3	5	2	12	11	9	8	13	2
13	6	3	2	10	2	13	15	15	14	15	0
15	6	14	2	13	2	15	15	15	14	13	2
16	6	5	3	11	2	11	11	12	12	11	1
17	6	5	3	7	4	10	9	10	10	10	1
18	6	6	2	13	2	15	15	15	15	15	0
20	8	1	8	15	3	11	10	10	8	8	2
4	9	0	3	4	2	13	15	15	15	15	0
21	12	2	6	4	4	11	12	11	12	12	1

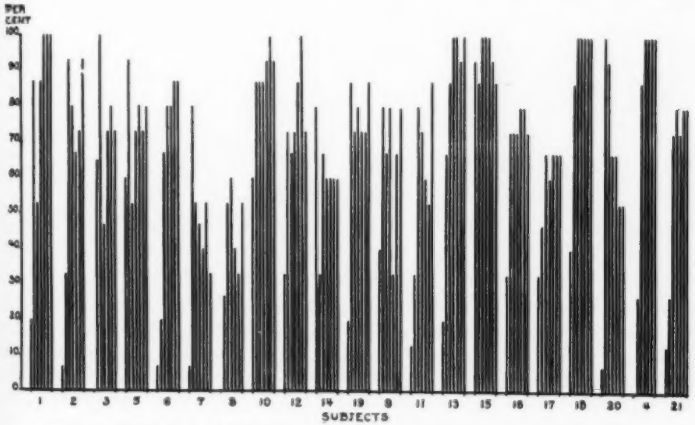

Fig. 37. Efficiency of Recall on the 15 Nonsense Syllables in Overlearning.

The relation of retention, as measured by relearning, to speed of learning is shown in Figure 38. The curves in this figure show a slight tendency for the rapid learners to relearn more rapidly on the first and second relearnings than for the slow learners. On the third relearning the slow learners relearned almost as quickly as did the fast learners.

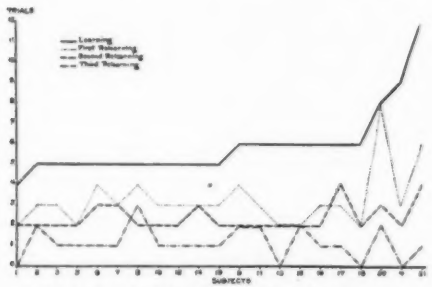

Fig. 38. Number of Trials Required by Each Subject in Learning and Relearning the 15 Nonsense Syllables in Overlearning.

TABLE XLIII. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 15 NONSENSE SYLLABLES IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
1	1	11	3	5	8	19.5	6.5	3	3	2.5	2.5
2	6.5	16.5	11	16	8	4	10	15	13	5.5	18
3	6.5	20	11	12.5	8	2	20.5	12	10	15	10
5	6.5	3.5	3	2	8	19.5	5	9	13	12	10
6	6.5	16.5	18	21	17.5	15	10	9	8	8.5	10
7	6.5	16.5	11	8.5	17.5	19.5	20.5	19.5	19	21	10
8	6.5	20	18	19	8	19.5	18	19.5	21	19.5	21
10	6.5	3.5	11	5	8	6	6.5	6	3	5.5	10
12	6.5	8	11	10.5	8	15	14	7	3	15	10
14	6.5	2	11	16	17.5	15	18	17.5	17	18	10
19	6.5	11	11	5	8	10.5	10	12	13	8.5	10
9	15	5.5	18	8.5	8	15	10	21	15.5	12	18
11	15	13.5	11	16	8	8	14	17.5	19	8.5	18
13	15	11	3	12.5	8	6	2.5	3	6.5	2.5	2.5
15	15	1	3	5	8	2	2.5	3	6.5	8.5	18
16	15	8	11	10.5	8	10.5	14	9	10	15	10
17	15	8	11	14	20.5	15	18	15	15.5	17	10
18	15	5.5	3	5	8	2	2.5	3	3	2.5	2.5
20	19	16.5	21	1	17.5	10.5	16	15	19	19.5	18
4	20	20	11	19	8	6	2.5	3	3	2.5	2.5
21	21	13.5	20	19	20.5	10.5	10	12	10	12	10
Correlation...		.10	.36	.20	.44	−.29	−.13	.02	.10	.04	.19
P.E.$_r$.....		±.15	±.13	±.15	±.13	±.14	±.15	±.15	±.15	±.15	±.15

The changes in rank of each subject are shown in Table XLIII. Subject 1, who was the fastest learner, ranked 11, 5, 19.5, 6.5, 3, 3, and 2.5 on the memory tests, and 3, 8, and 2.5 on the three relearnings; and Subject 21, who was the slowest learner, ranked 13.5, 19, 10.5, 10, 12, 10, and 12 on the memory tests, and 20, 20.5, and 10 on the relearnings. The marked changes in position of the subjects indicate that there is no high degree of relation between retention and speed of learning. The correlations of speed of learning with memory test scores and speed of relearning are all too low to show any definite trend toward either a positive or negative relation.

The average number of trials required to learn the symbols, the average memory test scores, and the average number of trials required

to relearn by the upper, middle, and lower thirds of the group are given in Table XLIV. The upper third required .5 fewer trials to learn the syllables than did the middle group and 2.7 fewer trials than the lower third. On the first memory test the middle third was most efficient in recall, reproducing 5.7 of the syllables. The upper third recalled only 2.1 and the lower group 4.7. On the first relearning the upper and middle groups required 3 trials each, and the lower third, 3.9 trials, but on the third the lower and middle groups took fewer trials than the upper group.

The relation between retention, as measured by the efficiency of recall, and speed of learning for the three groups is shown more clearly by the curves in Figure 39, which are based on percentages. On all seven memory tests the three curves are so close together that one may conclude that the group of slow learners was just as efficient in recall as was the group of fast learners.

A study of all the data concerning the relation between the speed of learning 15 nonsense syllables and the ability to recall and relearn them later indicates that there is little, if any, positive relation between retention and speed of learning.

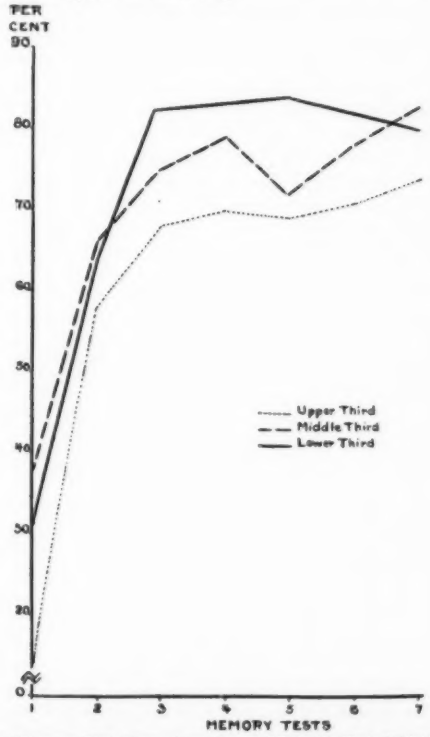

Fig. 39. Average Memory Test Percentage Scores Made by Each Third of the Group on the 15 Nonsense Syllables in Overlearning.

TABLE XLIV. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 15 NONSENSE SYLLABLES IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
Upper third	4.9	2.1	3.0	8.7	2.3	10.1	10.6	10.3	10.7	11.1	1.3
Middle third	5.4	5.7	3.0	9.9	2.1	11.3	11.9	10.9	11.7	12.4	1.1
Lower third	7.6	4.7	3.9	9.6	2.7	12.3	12.4	12.6	12.3	12.0	1.0

2. Words. The seven memory tests following the overlearning of the 25 words came at intervals of 7, 7, 14, 5, 7, 8, and 8 days. The first relearning came 7 days after the original learning; the second, 14 days after learning and 7 days after the first relearning; and the third, 56 days after learning, 49 days after the first relearning, and 42 days after the second relearning (Table I).

The number of trials required to produce two correct, consecutive copies of the 25 words, the seven memory test scores, and the number of trials required for each relearning are given in Table XLV. The range in number of learning trials is from 5 to 11. Subjects 1, 2, and 10 learned the 25 words in 5 trials each; while Subject 21 required 11 trials, or more than twice as many. On the first memory test Subject 1 recalled 3 of the syllables, Subjects 2 and 10 recalled 6 each, and Subject 21 recalled only 2. On the first relearning, Subject 1 needed 2 trials, Subjects 2 and 10 relearned in 3 trials, and Subject 21 took 7 trials.

The scores in Table XLV, when read from left to right, show the relation between retention and speed of learning for each individual. When read from top to bottom they show the relation of the 21 subjects to one another in both retention and speed of learning.

TABLE XLV. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 25 WORDS IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
1	5	3	2	13	2	25	25	25	23	25	0
2	5	6	3	20	2	25	25	25	25	25	0
10	5	6	3	25	2	25	25	25	25	25	0
5	6	12	3	19	2	25	22	18	24	18	1
7	6	3	3	22	2	23	23	21	21	25	0
14	6	1	5	17	3	19	18	16	18	22	1
15	6	3	4	21	2	25	25	23	23	25	0
18	6	9	2	25	2	25	25	25	25	25	0
3	7	1	4	11	3	23	10	9	20	18	1
6	7	1	5	12	3	18	13	18	13	20	3
8	7	0	5	7	4	16	15	18	14	18	1
12	7	1	4	16	2	21	22	17	20	21	1
13	7	3	3	15	2	25	25	23	23	23	1
17	7	1	3	18	2	19	22	20	20	25	0
4	8	5	8	11	2	23	23	23	17	23	1
9	8	7	4	12	2	21	17	18	18	17	1
16	8	4	4	25	2	23	25	25	25	25	0
19	8	11	3	23	2	25	25	25	25	25	0
11	9	9	2	8	2	24	23	18	18	25	0
20	9	6	3	23	2	25	25	23	21	23	1
21	11	2	7	6	4	11	16	14	11	16	1

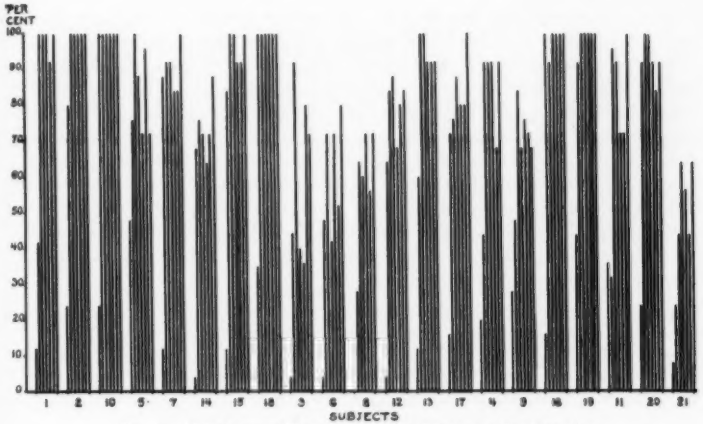

Fig. 40. Efficiency of Recall on the 25 Words in Overlearning.

The memory test scores, expressed in percentages, are shown in graphical form in Figure 40. Many of the curves are quite irregular in shape, but approximately half of the number are more nearly flat than any other shape, showing that there was little difference in efficiency for these subjects on the seven memory tests. The bars as a whole form a linear curve with little, if any, tendency toward either negative or positive acceleration.

A comparison of the number of trials required to relearn with the number of learning trials shows considerable variation between the two. The curves in Figure 41 indicate a little tendency, however, for those who learned most rapidly to relearn more quickly than those who learned slowly.

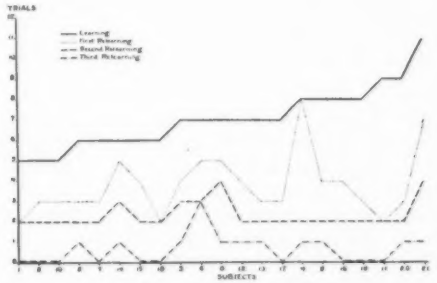

Fig. 41. Number of Trials Required by Each Subject in Learning and Relearning the 25 Words in Overlearning.

The changes in rank of each subject are shown in Table XLVI. Subject 1, who was one of the three most rapid learners, ranked 12.5, 14, 5, 5, 3.5, 8, and 5.5 on the seven memory tests, and 2, 8.5, and 5.5 in speed of relearning. Subject 16, who ranked 16.5 in speed of learning,

ranked 10, 2, 12.5, 5, 3.5, 3, and 5.5 on the memory tests, and 14, 8.5, and 5.5 in speed of relearning. Subject 21, the slowest learner of the 21 subjects, ranked 15, 21, 21, 18, 20, 21, and 21 on the seven memory tests, and 20, 20.5, and 15.5 in speed of relearning. The tendency for the subjects to maintain a relatively constant position in speed of learning, memory test scores, and speed of relearning presents some evidence that fast learners are slightly more efficient both in recall and relearning than slow learners. The correlations of speed of learning with memory scores and number of relearning trials (Table XLVI) are sufficiently high to indicate that there is a tendency for fast learners to recall more and to relearn faster than the slower group on all memory tests except the first.

TABLE XLVI. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 25 WORDS IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
1	2	12.5	2	14	8.5	5	5	3.5	8	5.5	5.5
2	2	7	7.5	8	8.5	5	5	3.5	3	5.5	5.5
10	2	7	7.5	2	8.5	5	5	3.5	3	5.5	5.5
5	6	1	7.5	9	8.5	5	14	15	6	18	15.5
7	6	12.5	7.5	6	8.5	12.5	11	11	10.5	5.5	5.5
14	6	18	18	11	18	17.5	16	19	16	14	15.5
15	6	12.5	14	7	8.5	5	5	8.5	8	5.5	5.5
18	6	3.5	2	2	8.5	5	5	3.5	3	5.5	5.5
3	11.5	18	14	17.5	18	12.5	21	21	13	18	15.5
6	11.5	18	18	15.5	18	19	20	15	20	16	21
8	11.5	21	18	20	20.5	20	19	15	19	18	15.5
12	11.5	18	14	12	8.5	15.5	14	18	13	15	15.5
13	11.5	12.5	7.5	13	8.5	5	5	8.5	8	12	15.5
17	11.5	18	7.5	10	8.5	17.5	14	12	13	5.5	5.5
4	16.5	9	21	17.5	8.5	12.5	11	8.5	18	12	15.5
9	16.5	5	14	15.5	8.5	15.5	17	15	16	20	15.5
16	16.5	10	14	2	8.5	12.5	5	3.5	3	5.5	5.5
19	16.5	2	7.5	4.5	8.5	5	5	3.5	3	5.5	5.5
11	19.5	3.5	2	19	8.5	10	11	15	16	5.5	5.5
20	19.5	7	7.5	4.5	8.5	5	5	8.5	10.5	12	15.5
21	21	15	20	21	20.5	21	18	20	21	21	15.5
Correlation...		−.02	.37	.39	.37	.44	.32	.35	.51	.42	.45
P.E.$_r$.....		±.15	±.13	±.13	±.13	±.12	±.14	±.14	±.11	±.13	±.12

The average number of trials required to learn the words, the average memory test scores, and the average number of trials required for relearning by the upper, middle, and lower thirds of the group are given in Table XLVII. The upper third required 1.3 fewer trials than the middle group and 3.1 fewer trials than the lower group to learn the 25 words. On the first memory test the lower third recalled more words than either of the other two groups, but the upper third recalled the most on each of the other memory tests. On the first relearning the difference in number of trials required by the three groups was similar to that on learning; on the second and third relearnings the middle group required more trials than either of the other groups.

The relation between retention as measured by the efficiency of recall and speed of learning is shown in Figure 42, which is based on percentages. On all memory tests except the first, the upper group was

TABLE XLVII. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 25 WORDS IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
Upper third	5.6	4.9	3.3	19.6	2.1	23.9	23.3	21.9	22.7	23.6	0.3
Middle third	6.9	2.3	3.7	14.9	2.6	21.0	18.9	18.6	19.3	21.4	1.0
Lower third	8.7	6.3	4.4	15.4	2.3	21.7	22.0	20.9	19.3	22.0	0.6

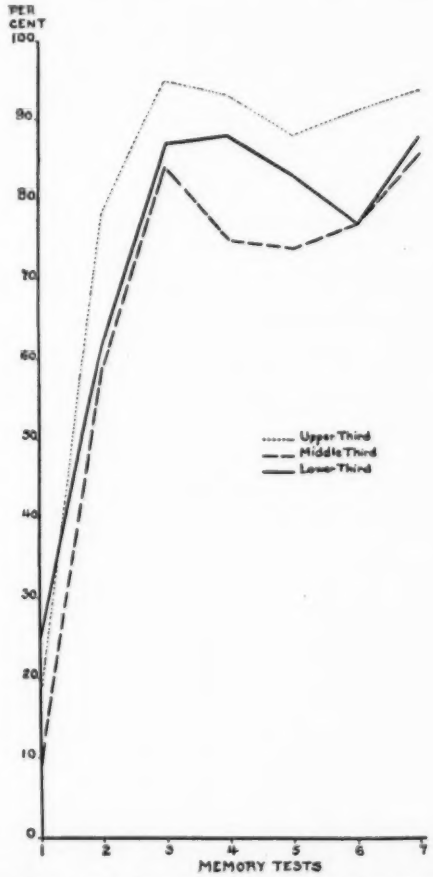

Fig. 42. Average Memory Test Percentage Scores Made by Each Third of the Group on the 25 Words in Overlearning.

more efficient than the middle or lower thirds; and on all seven of the tests the lower third recalled as many or more words than the middle group. The distance between the three curves is not great on any of the memory tests.

An evaluation of all the data concerning the speed of learning 25 words and the ability to recall and relearn them later shows a tendency for the fast learners to be more efficient in recall and also to relearn with fewer trials than slow learners. The evidence is not convincing, but the trend is apparent.

3. Names and Dates. The seven memory tests following the overlearning of the 20 names and dates came at intervals of 7, 8, 15, 5, 7, 7, and 9 days. The first relearning came 7 days after the original learning; the second, 15 days after learning and 8 days after the first relearning; and the third, 58 days after learning, 51 days after the first relearning, and 43 days after the second relearning (Table I).

The number of learning trials, memory test scores, and relearning trials for each subject are given in Table XLVIII. The range of learning trials is from 5 to 13. Subject 2 learned the names and dates in 5 trials; Subject 21 required 13 trials, more than twice as many.

On the first memory test Subject 2 recalled 10, or 50 per cent, and Subject 21 recalled only 1. On the first relearning Subject 2 required 3 trials to relearn, while Subject 21 required 10 trials.

The scores in Table XLVIII, when read from left to right, show the relation between retention and speed of learning for each individual. When read from top to bottom they show the relation of the 21 subjects to each other in both retention and speed of learning.

TABLE XLVIII. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 20 NAMES AND DATES IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
2	5	10	3	18	2	20	20	20	20	19	1
1	6	8	2	15	2	20	20	20	20	20	0
3	6	3	3	15	2	20	20	20	16	20	0
8	6	2	2	3	2	18	17	18	19	16	1
10	6	8	2	18	2	20	20	20	20	19	1
12	6	7	5	13	2	20	19	18	18	18	3
5	7	7	3	11	2	20	17	17	15	20	0
7	7	15	3	18	2	20	19	20	20	20	0
9	7	2	5	17	3	20	20	20	20	20	0
4	8	2	5	14	2	17	17	18	18	20	0
11	8	3	4	10	4	17	17	20	18	18	1
13	8	11	2	15	3	18	18	18	18	20	0
16	8	3	3	17	2	20	20	20	20	20	0
19	8	8	2	17	2	20	20	20	20	20	0
14	9	11	2	18	2	20	15	20	18	18	1
18	9	11	2	19	2	20	15	20	20	20	0
15	10	6	2	20	2	20	19	20	20	20	0
6	11	2	4	6	3	18	17	17	16	15	1
17	11	2	3	15	2	20	20	20	20	20	0
20	11	3	3	16	2	20	20	20	20	20	0
21	13	1	10	3	4	11	10	13	12	13	1

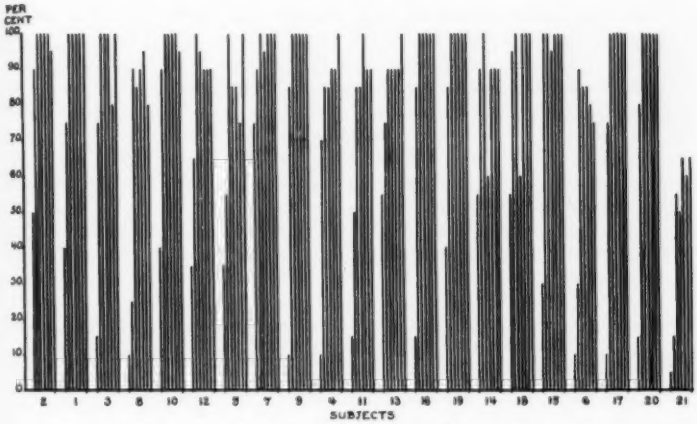

Fig. 43. Efficiency of Recall on the 20 Names and Dates in Overlearning.

The memory test scores, expressed in percentages, are shown in graphical form in Figure 43. The predominant shape of the individual memory curves is linear and the contour of the bars as a whole is linear with a tendency toward negative acceleration at the extreme right end of the curve. The curve is practically a straight line until it reaches the last two bars, where there is a drop.

There is considerable variation between the number of trials required to learn the material and the number required to relearn it. The curves in Figure 44 show no positive relation between speed of learning and relearning for the first and third relearning, but there is a slight tendency for the rapid learners to relearn more rapidly than the slow learners on the second relearning.

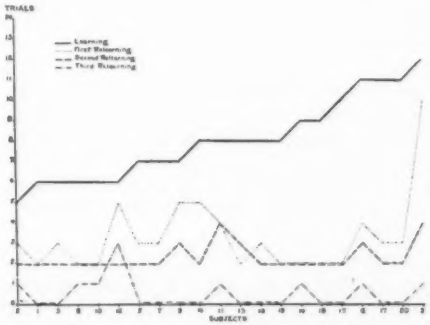

Fig. 44. Number of Trials Required by Each Subject in Learning and Relearning the 20 Names and Dates in Overlearning.

The changes in rank of each subject are shown in Table XLIX. Subject 2, who was the fastest learner, ranked 5, 4.5, 8, 5, 7.5, 6, and 14.5 on the seven memory tests, and 12, 8.5, and 17 in relearning. Subject 21, the slowest learner, maintained his position at the bottom of the ranking on all the memory tests and two of the relearning trials. Subject 19, who ranked 12 in speed of learning, ranked 7, 8, 8, 5, 7.5, 6, and 7 on the memory tests, and 4.5, 8.5, and 7 in relearning. The great variation in rankings indicates that there is little positive relation between retention and speed of learning.

The correlations (Table XLIX) of speed of learning with memory test scores and speed of relearning are too low to show any significant positive relation.

TABLE XLIX. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 20 NAMES AND DATES IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
2	1	5	12	4.5	8.5	8	5	7.5	6	14.5	17
1	4	7	4.5	12.5	8.5	8	5	7.5	6	7	7
3	4	13.5	12	12.5	8.5	8	5	7.5	18.5	7	7
8	4	18	4.5	20	8.5	17	16	16.5	12	19	17
10	4	7	4.5	4.5	8.5	8	5	7.5	6	14.5	17
12	4	9.5	19	16	8.5	8	11	16.5	15	17	21
5	8	9.5	12	17	8.5	8	16	19.5	20	7	7
7	8	1	12	4.5	8.5	8	11	7.5	6	7	7
9	8	18	19	8	18	8	5	7.5	6	7	7
4	12	18	19	15	8.5	19.5	16	16.5	15	7	7
11	12	13.5	16.5	18	20.5	19.5	16	7.5	15	17	17
13	12	3	4.5	12.5	18	17	13	16.5	15	7	7
16	12	13.5	12	8	8.5	8	5	7.5	6	7	7
19	12	7	4.5	8	8.5	8	5	7.5	6	7	7
14	15.5	3	4.5	4.5	8.5	8	19.5	7.5	15	17	17
18	15.5	3	4.5	2	8.5	8	19.5	7.5	6	7	7
15	17	11	4.5	1	8.5	8	11	7.5	6	7	7
6	19	18	16.5	19	18	17	16	19.5	18.5	20	17
17	19	18	12	12.5	8.5	8	5	7.5	6	7	7
20	19	13.5	12	10	8.5	8	5	7.5	6	7	7
21	21	21	21	21	20.5	21	21	21	21	21	17
Correlation...		.34	.20	.08	.50	.44	.44	.29	.21	.17	.02
P.E.$_r$.....		±.13	±.14	±.15	±.11	±.12	±.12	±.14	±.15	±.15	±.15

The average number of trials required to learn the 20 names and dates, the average memory test scores, and the average number of relearning trials for the upper, middle, and lower thirds of the group are given in Table L. The upper third required 1.7 fewer trials to learn the words than the middle group and 4.6 fewer trials than the lower group. On all the memory tests except the second, the lower third is below both the upper and the middle thirds.

The relation between retention and speed of learning for the three groups is shown in Figure 45, which is based on percentages. The curves in the figure are close together on all seven memory tests, indicating neither a definite positive or negative relation between retention and speed of learning.

TABLE L. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 20 NAMES AND DATES IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
Upper third	6.0	0.4	2.9	13.6	2.0	19.7	19.0	19.0	18.3	18.9	0.9
Middle third	7.7	0.3	3.4	15.4	2.6	18.9	18.7	19.4	19.1	19.7	0.1
Lower third	10.6	5.1	3.7	13.9	2.4	18.4	16.6	18.6	18.0	18.0	0.4

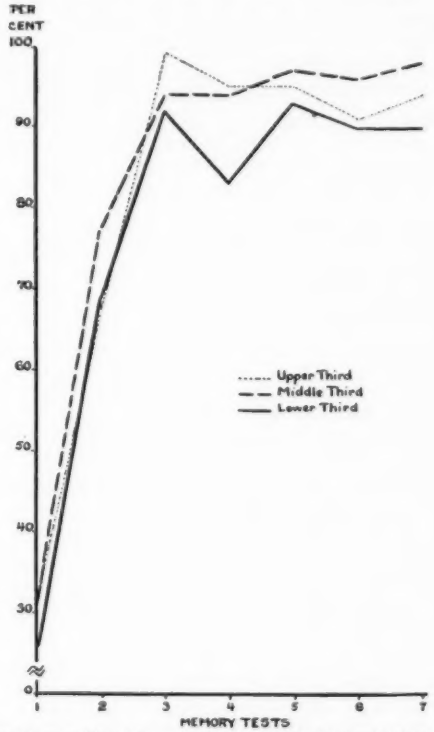

Fig. 45. Average Memory Test Percentage Scores Made by Each Third of the Group on the 20 Names and Dates in Overlearning.

An evaluation of all the data concerning the overlearning of 20 names and dates and the ability to recall and relearn them later indicates that slow learners recall and relearn just as efficiently as fast learners.

4. Geometric Figures. The seven memory tests following the overlearning of the 12 geometric figures came at intervals of 7, 7, 19, 7, 9, 5, and 7 days. The first relearning came 7 days after learn-

ing; the second 14 days after learning and 7 days after the first relearning; the third 61 days after learning, 54 days after the first relearning, and 47 days after the second relearning (Table I).

The number of trials required by each subject to produce two correct consecutive copies of the geometric figures, the seven memory test scores, and the number of trials required for each relearning are given in Table LI. The range in learning trials is from 6 to 10. Subjects 3, 8, and 11 learned the 12 geometric figures in 6 trials each, while Subject 9 required 10 trials. The slowest learner required 4 more trials to learn than did the three fastest learners. On the first memory test the three fastest learners recalled 7, 8, and 12 of the geometric figures. Subject 9, the slowest learner, recalled all 12. Subject 16, who required 8 trials to learn, also recalled 100 per cent on the first memory test. On the first relearning each of the subjects mentioned required 2 trials, except Subject 16, who required 3.

When the scores in Table LI are read from left to right, they show the relation between retention and speed of learning for each individual. When read from top to bottom, they show the relation of the subjects to one another in both retention and speed of learning.

The memory test scores, expressed in percentages, are shown in graphical form in Figure 46. The predominant shape of the individual memory curves is linear and the contour of the bars as a whole is linear, showing no tendency for rapid learners to be more efficient in recall than slow learners.

TABLE LI. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 12 GEOMETRIC FIGURES IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
3	6	7	2	11	2	10	12	12	12	12	0
8	6	8	2	11	2	11	7	7	8	10	1
11	6	12	2	12	2	12	12	12	12	11	1
1	7	12	2	12	2	12	12	12	12	12	0
6	7	0	4	8	2	8	11	12	11	12	0
14	7	10	2	10	2	11	12	12	12	12	0
15	7	11	2	12	2	12	12	12	12	12	0
18	7	8	2	11	2	12	12	12	12	11	2
19	7	12	2	12	2	12	12	12	12	12	0
21	7	11	2	8	2	12	12	12	12	12	0
2	8	12	2	7	2	12	12	12	12	12	0
5	8	12	2	12	2	12	12	12	12	12	0
7	8	9	2	9	2	11	12	12	11	12	0
10	8	7	2	5	2	12	12	12	12	11	1
12	8	10	2	12	2	12	12	11	12	11	1
13	8	10	2	4	3	12	12	11	11	12	0
16	8	12	3	12	2	12	12	12	12	12	0
4	9	8	2	10	2	11	12	11	12	12	0
17	9	12	2	12	2	12	12	11	12	12	0
20	9	12	2	11	2	12	12	12	12	11	1
9	10	12	2	12	2	12	11	12	11	11	1

The relation between retention as measured by relearning and speed of learning is shown in Figure 47. Not one of the three relearning curves conforms to the shape of the learning curve, which shows that

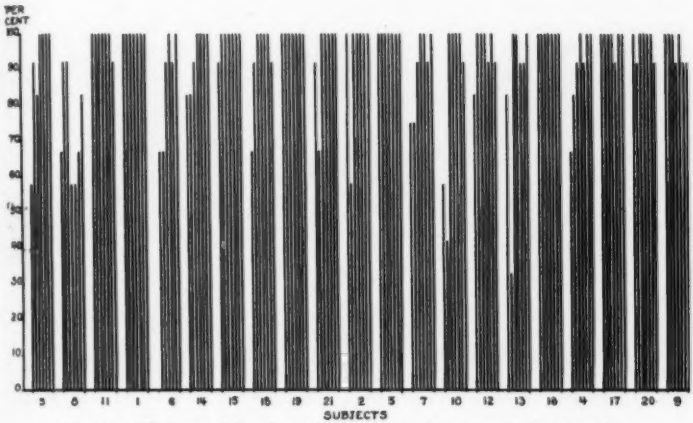

Fig. 46. Efficiency of Recall on the 12 Geometric Figures in Overlearning.

there is no tendency for fast learners of the geometric figures to relearn more quickly than slow learners.

The changes in rank of each subject are given in Table LII. Subject 3, who was one of the three most rapid learners, ranked 19.5, 11.5, 20, 9.5, 8.5, 8.5, and 7.5 on the seven memory tests, and 10, 10.5, and 7.5 on the three relearnings. Subject 16, who ranked 14 in speed of learning, ranked 5, 5, 8, 9.5, 8.5, 8.5, and 7.5 on the memory tests, and 20, 10.5, and 7.5 on the relearnings. Subject 9, the slowest learner of the 21 subjects, ranked 5, 5, 8, 19.5, 8.5, 18.5, and 17.5 on the memory tests, and 10, 10.5, and 17.5 on speed of relearning. The lack of constancy between speed of learning, rankings on memory tests, and relearning indicates that there is no tendency for rapid learners of the geometric figures to be more efficient in either recall or relearning than slow learners.

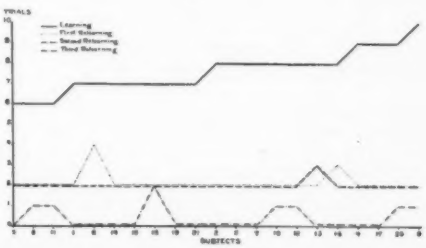

Fig. 47. Number of Trials Required by Each Subject in Learning and Relearning the 12 Geometric Figures in Overlearning.

Further evidence of the lack of any significant positive relation between retention and speed of learning geometric figures is given in the correlations in Table LII. The correlations of speed of relearning

with the first and second relearnings and the fifth memory test scores are high enough to be significant, but the fact that the other correlations are low indicates that the high correlations are an incidence of measurement rather than a trend toward a positive relation between retention and speed of learning.

TABLE LII. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 12 GEOMETRIC FIGURES IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
3	2	19.5	10	11.5	10.5	20	9.5	8.5	8.5	7.5	7.5
8	2	17	10	11.5	10.5	17.5	21	21	21	21	17.5
11	2	5	10	5	10.5	8	9.5	8.5	8.5	17.5	17.5
1	7	5	10	5	10.5	8	9.5	8.5	8.5	7.5	7.5
6	7	21	21	17.5	10.5	21	19.5	8.5	18.5	7.5	7.5
14	7	13	10	14.5	10.5	17.5	9.5	8.5	8.5	7.5	7.5
15	7	10.5	10	5	10.5	8	9.5	8.5	8.5	7.5	7.5
18	7	17	10	11.5	10.5	8	9.5	8.5	8.5	17.5	21
19	7	5	10	5	10.5	8	9.5	8.5	8.5	7.5	7.5
21	7	10.5	10	17.5	10.5	8	9.5	8.5	8.5	7.5	7.5
2	14	5	10	19	10.5	8	9.5	8.5	8.5	7.5	7.5
5	14	5	10	5	10.5	8	9.5	8.5	8.5	7.5	7.5
7	14	15	10	16	10.5	17.5	9.5	8.5	18.5	7.5	7.5
10	14	19.5	10	20	10.5	8	9.5	8.5	8.5	17.5	17.5
12	14	13	10	5	10.5	8	9.5	18.5	8.5	17.5	17.5
13	14	13	10	21	21	8	9.5	18.5	18.5	7.5	7.5
16	14	5	20	5	10.5	8	9.5	8.5	8.5	7.5	7.5
4	19	17	10	14.5	10.5	17.5	9.5	18.5	8.5	7.5	7.5
17	19	5	10	5	10.5	8	9.5	18.5	8.5	7.5	7.5
20	19	5	10	11.5	10.5	8	9.5	8.5	8.5	17.5	17.5
9	21	5	10	5	10.5	8	19.5	8.5	18.5	17.5	17.5
Correlation...		−.20	.41	.10	.53	−.01	.31	.43	.28	.19	.22
$P.E._r$.....		±.15	±.13	±.15	±.11	±.15	±.14	±.13	±.14	±.15	±.14

The average number of trials required to learn the geometric figures, the average memory test scores, and the average number of trials required for each relearning for the upper, middle, and lower thirds of the group are given in Table LIII. The lower third required 1.1 more trials to learn than the middle third and 2.1 more than the upper group. On the first memory test the lower third recalled more than either of the other groups. On the last five memory tests the three groups are unusually close together. The number of relearning trials needed is also very nearly the same for all groups.

TABLE LIII. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 12 GEOMETRIC FIGURES IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
Upper third	6.6	7.1	2.3	10.9	2.0	10.9	11.1	11.3	11.3	11.6	0.3
Middle third	7.6	10.1	2.0	9.1	2.0	11.9	12.0	12.0	11.9	11.7	0.4
Lower third	8.7	10.9	2.1	10.4	2.1	11.9	11.9	11.4	11.7	11.6	0.4

The relation between retention and speed of learning for the three groups is shown more clearly in Figure 48. The three curves are so close together for all seven memory tests that one may conclude that the group of slowest learners was just as efficient in recall as was the group of most rapid learners.

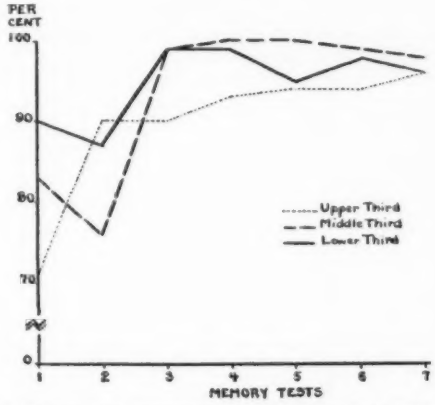

Fig. 48. Average Memory Test Percentage Scores Made by Each Third of the Group on the 12 Geometric Figures in Overlearning.

An evaluation of all the data concerning the relation between the speed of learning 12 geometric figures and the ability to recall and relearn them later shows no significant positive relation between retention and speed of learning.

5. Symbols. The seven memory tests following the overlearning of the 60 symbols came at intervals of 7, 7, 26, 7, 7, 7, and 7 days. The first relearning came 7 days after original learning; the second relearning came 14 days after learning and 7 days after the first relearning; and the third relearning came 68 days after learning, 61 days after the first relearning, and 54 days after the second relearning (Table I).

The number of trials required by each subject to make two correct consecutive reproductions of the 60 symbols, the seven memory test scores, and the number of trials required by each subject for the three relearnings are given in Table LIV. The range of number of learning trials is from 8 to 17. Subject 1 learned the 60 symbols in 8 trials, less than half as many as Subject 21, who required 17. On the first memory test Subject 1 recalled 53 and Subject 21 recalled all 60 symbols. Subject 2, who required 10 trials to learn, recalled 50 on the first memory test. On the first relearning the individual learning fastest, the individual learning at more nearly average speed, and the individual learning slowest, each required 2 trials to relearn the symbols.

The scores in Table LIV, when read from left to right, show the relation between retention and speed of learning for each individual. When read from top to bottom, they show the relation of the 21 subjects to one another in both retention and speed of learning.

TABLE LIV. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 60 SYMBOLS IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
1	8	53	2	59	2	56	60	60	60	60	0
3	9	31	2	54	2	50	52	42	43	58	2
8	9	27	3	58	2	25	35	32	39	42	2
10	9	38	2	57	2	48	53	54	55	57	3
11	9	49	3	50	2	33	36	41	52	53	1
14	9	24	3	32	2	22	15	24	18	21	2
15	9	59	2	52	2	52	60	60	50	59	1
18	9	40	2	48	2	58	59	59	59	57	1
2	10	50	2	58	2	60	59	58	60	58	1
5	10	17	2	56	2	54	53	52	55	56	1
16	10	32	2	56	2	53	52	56	57	58	1
17	10	30	2	56	3	59	57	60	58	58	1
19	10	57	2	60	2	40	52	56	48	58	2
20	10	25	3	45	2	60	56	55	55	60	0
4	11	54	2	47	2	38	42	38	43	43	1
7	11	22	2	36	2	31	16	21	27	27	3
6	13	40	2	39	2	52	57	57	57	53	1
9	14	36	3	57	3	43	50	52	53	53	1
12	14	55	2	51	2	49	48	55	55	58	1
13	14	58	4	60	2	59	59	60	60	60	0
21	17	60	2	51	2	20	43	43	28	46	2

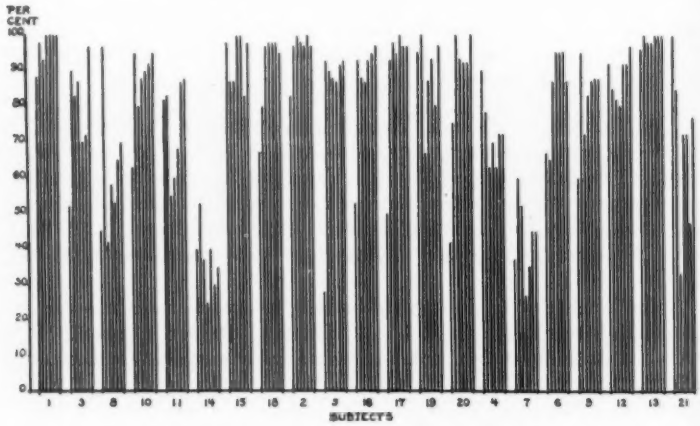

Fig. 49. Efficiency of Recall on the 60 Symbols in Overlearning.

The memory test scores, expressed in percentages, are shown in graphical form in Figure 49. A study of the individual bars shows no definite trend in the shape of the memory curves. A few of the individual curves are linear, some are slightly bell-shaped, some are in the form of inverted bell-shaped curves, and still others are so irregular

that they conform to no definite form. The contour of the bars as a whole is more nearly that of a linear curve.

A study of the relation between retention as measured by the number of trials required to relearn and speed of learning presents no evidence that fast learners relearn more rapidly than slow learners. The number of trials required by each subject to relearn the symbols for each of the three relearnings is shown in Figure 50. An examination of these curves shows that in some cases the fast learners relearn slowly just as in other cases the slow learners relearn rapidly. Variations in speed of relearning are purely individual and there is no evidence that slow learners as a group relearn slowly.

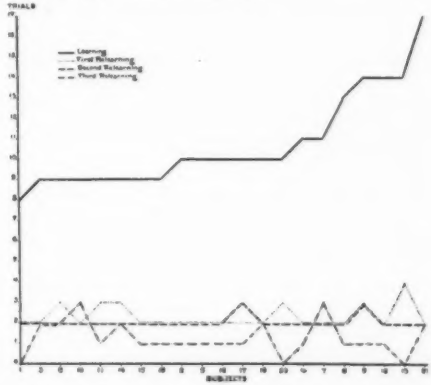

Fig. 50. Number of Trials Required by Each Subject in Learning and Relearning the 60 Symbols in Overlearning.

The changes in rank of each subject are given in Table LV. Subject 1, who was the most rapid learner, ranked 7, 3, 6, 1.5, 2.5, 2, and 2 on the seven memory tests, and 8, 10, and 2 on the three relearnings. Subject 2, who ranked 11.5 in speed of learning, ranked 8, 4.5, 1.5, 4, 6, 2, and 7.5 on the memory tests and 8, 10, and 9 on the relearnings; and Subject 21, the slowest learner, ranked 1, 13.5, 21, 16, 15, 19, and 17 on the memory tests, and 8, 10, and 17 on the three relearnings. The rankings in Table LV show that there is no tendency for those who were rapid in learning the symbols to retain their position in either the memory tests or the relearning trials.

The correlations (Table LV) between retention and speed of learning show no significant relation between the speed of learning 60 symbols and the ability to recall and relearn them later.

The average number of trials required to learn the symbols, the average memory scores, and the average number of trials required for each relearning for the upper, middle, and lower thirds are given in Table LVI. The lower third needed 4.5 more trials to learn the symbols than did the upper group and 3.5 more than did the middle third. On the first memory test, however, the lower group recalled 46.4 symbols, or 77 per cent, while the middle third recalled only 60 per cent, and the

upper third 66 per cent. On all the other memory tests the middle group was the most efficient.

The relation between retention and speed of learning for the three groups is shown in Figure 51, which is based on percentages. The superiority of the middle group in ability to recall the symbols is very evident in this figure. The curves for the upper and lower groups are practically together on all seven memory tests, showing that the group of slow learners was just as efficient in recall as was the group of fast learners.

An evaluation of all the data concerning the speed of learning 60 symbols and the ability to recall and relearn them later indicates that there is little, if any, relation between retention and speed of learning.

TABLE LV. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE 60 SYMBOLS IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
1	1	7	8	3	10	6	1.5	2.5	2	2	2
3	5	15	8	11	10	11	12	16	16.5	7.5	17
8	8	17	18	4.5	10	19	19	19	18	19	17
10	5	12	8	6.5	10	13	9.5	12	9.5	11.5	20.5
11	5	9	18	15	10	17	18	17	13	15	9
14	5	19	18	21	10	20	21	20	21	21	17
15	3	2	8	12	10	9.5	1.5	2.5	14	4	9
18	5	10.5	8	16	10	5	4	5	4	11.5	9
2	11.5	8	8	4.5	10	1.5	4	6	2	7.5	9
5	11.5	21	8	9	10	7	9.5	13.5	9.5	13	9
16	11.5	14	8	9	10	8	12	8.5	6.5	7.5	9
17	11.5	16	8	9	20.5	3.5	6.5	2.5	5	7.5	9
19	11.5	4	8	1.5	10	15	12	8.5	15	7.5	17
20	11.5	18	18	18	10	1.5	8	10.5	9.5	2	2
4	15.5	6	8	17	10	16	17	18	16.5	18	9
7	15.5	20	8	20	10	18	20	21	20	20	20.5
6	17	10.5	8	19	10	9.5	6.5	7	6.5	15	9
9	19	13	18	6.5	20.5	14	14	13.5	12	15	9
12	19	5	8	13.5	10	12	15	10.5	9.5	7.5	9
13	19	3	21	1.5	10	3.5	4	2.5	2	2	2
21	21	1	8	13.5	10	21	16	15	19	17	17
Correlation . . .		− .21	.24	.13	.54	.09	.21	.07	.05	.18	.02
P.E.$_r$		± .15	± .14	± .15	± .11	± .15	± .14	± .15	± .15	± .15	± .15

TABLE LVI. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE 60 SYMBOLS IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
Upper third	8.9	40.1	2.4	51.7	2.0	40.9	44.4	44.7	45.3	50.0	1.6
Middle third	9.9	35.9	2.1	54.1	2.1	54.9	55.4	56.6	56.0	57.9	1.0
Lower third	13.4	46.4	2.4	48.7	2.1	41.7	45.0	46.6	46.1	48.6	1.3

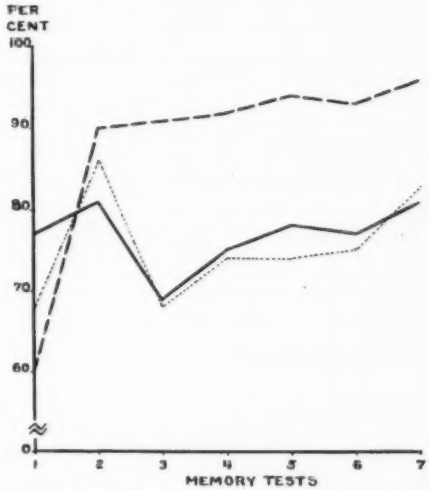

Fig. 51. Average Memory Test Percentage Scores Made by Each Third of the Group on the 60 Symbols in Overlearning.

6. Poetry. The seven memory tests for poetry came at intervals of 7, 7, 14, 2, 7, 7, and 8 days. The stanza of poetry was first relearned 7 days after the original learning; the second relearning was 14 days after the original learning and 7 days after the first relearning; and the third relearning came 52 days after original learning, 45 days after the first relearning, and 38 days after the second relearning (Table I).

TABLE LVII. LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE STANZA OF POETRY IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
1	8	33	2	79	2	97	99	99	99	99	0
2	8	83	2	92	2	96	97	97	96	96	1
6	8	21	3	92	2	97	98	98	96	96	1
5	8	2	4	93	2	97	97	96	97	99	0
3	9	10	2	97	2	99	98	98	98	99	0
5	9	52	2	88	2	92	95	93	92	94	1
9	9	38	3	73	2	93	94	97	96	94	1
11	9	39	3	57	2	95	90	88	93	96	1
13	9	5	3	94	2	99	99	99	99	99	0
14	9	22	2	36	2	67	70	89	90	95	3
15	9	85	2	89	2	99	98	99	99	99	0
10	9	47	3	94	2	97	97	98	98	99	0
4	10	29	3	90	2	96	94	97	95	94	1
10	10	10	4	86	2	92	94	94	94	95	1
12	10	42	3	89	2	98	99	98	98	99	0
16	11	34	3	44	2	98	98	98	98	99	0
7	12	10	6	58	2	70	70	71	71	91	4
17	12	7	4	94	2	96	96	95	96	96	1
18	12	50	3	97	2	98	98	98	98	99	0
20	12	8	5	94	2	97	97	99	98	99	0
21	13	6	5	82	2	92	91	93	89	90	2

The number of learning trials required by each subject to produce two correct consecutive copies of the poetry, the seven memory test scores, and the number of trials required by each subject to relearn the poetry are given in Table LVII. The range in number of learning trials is 8 to 13. Subjects 1, 2, 6, and 8 required 8 trials each to produce two correct, consecutive copies of the poetry; Subject 21 required 13 trials. On the first memory test Subject 1 recalled 33 of the 99 words; Subject 2, 83; Subject 6, 21; and Subject 8, only 2; while Subject 21 recalled 6. Subject 19, who learned at an average rate of speed, recalled 47 words on the first memory test. On the first relearning the slowest learner required 5 trials to relearn—more than any of the four fastest learners.

The scores in Table LVII, when read from left to right, show the relation between retention and speed of learning for each subject. When read from top to bottom, they indicate the relation of the 21 subjects to one another in retention and speed of learning.

The memory test scores, expressed in percentages, are shown in graphical form in Figure 52. There is considerable irregularity in the shape of the individual curves, the predominant curve being linear. The contour of the curves as a whole is linear, indicating that fast learners are no more efficient in recall than slow learners.

The relation between retention as measured by relearning and speed of learning is shown in Figure 53. On the first relearning there was a very definite tendency for the fast learners to relearn more rapidly than the slow learners. The tendency is less marked for the second relearning and almost disappears for the third relearning.

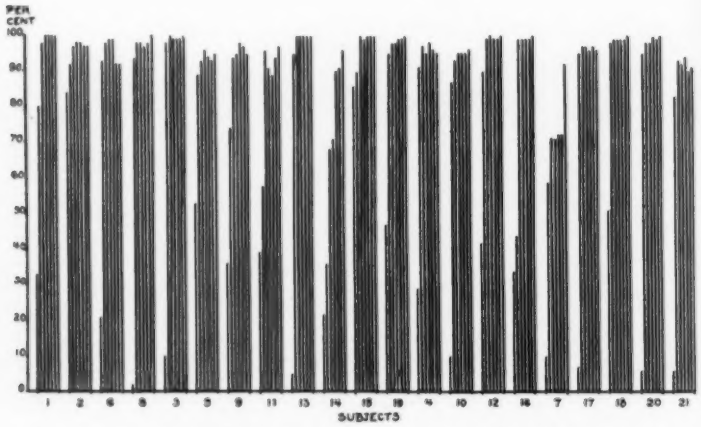

Fig. 52. Efficency of Recall on the Stanza of Poetry in Overlearning.

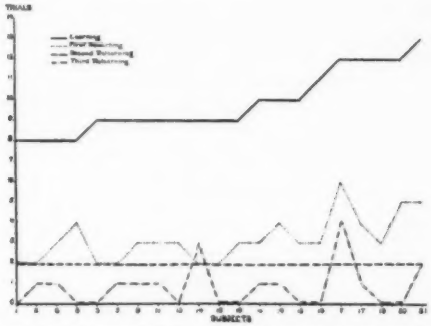

Fig. 53. Number of Trials Required by Each Subject in Learning and Relearning the Stanza of Poetry in Overlearning.

The changes in rank of each subject are given in Table LVIII. Subject 1, who was one of the four fastest learners, ranked 10, 16, 9, 2, 2.5, 2, and 5.5 on the seven memory tests, and 3.5, 11, and 5.5 on relearning. Subject 4, who ranked 14 in speed of learning, ranked 11, 10, 13, 16, 12, 15, and 18 on the memory tests, and 11, 11, and 14.5 on relearning. Subject 21, the slowest learner in the group, ranked 19, 15, 18, 18, 17.5, 20, and 21 on the memory tests, and 19.5, 11, and 19 on relearning.

There is little tendency for the subjects to maintain a constant position in both speed of learning and retention except for the first and second relearnings. With the exception of the correlations (Table LVIII) between speed of learning and the first two relearnings, the coefficients are too low to be significant.

TABLE LVIII. RANKS AND CORRELATIONS OF LEARNING, MEMORY TEST, AND RELEARNING SCORES ON THE STANZA OF POETRY IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
1	2.5	10	3.5	16	11	9	2	2.5	2	5.5	5.5
2	2.5	2	3.5	8.5	11	13	10.5	12	12.5	12.5	14.5
6	2.5	13	11	8.5	11	9	6	7.5	12.5	12.5	14.5
8	2.5	21	17	7	11	9	10.5	14	10	5.5	5.5
3	8.5	15	3.5	1.5	11	2	6	7.5	6.5	5.5	5.5
5	8.5	3	3.5	13	11	18	14	17.5	18	18	14.5
9	8.5	8	11	17	11	16	16	12	12.5	18	14.5
11	8.5	7	11	19	11	15	19	20	17	12.5	14.5
13	8.5	20	11	4.5	11	2	2	2.5	2	5.5	5.5
14	8.5	12	3.5	21	11	21	20.5	19	19	15.5	20
15	8.5	1	3.5	11.5	11	2	6	2.5	2	5.5	5.5
19	8.5	5	11	4.5	11	9	10.5	7.5	6.5	5.5	5.5
4	14	11	11	10	11	13	16	12	15	18	14.5
10	14	15	17	14	11	18	16	16	16	15.5	14.5
12	14	6	11	11.5	11	5	2	7.5	6.5	5.5	5.5
16	16	9	11	20	11	5	6	7.5	6.5	5.5	5.5
7	18.5	15	21	18	11	20	20.5	21	21	20	21
17	18.5	18	17	4.5	11	13	13	15	12.5	12.5	14.5
18	18.5	4	11	1.5	11	5	6	7.5	6.5	5.5	5.5
20	18.5	17	19.5	4.5	11	9	10.5	2.5	6.5	5.5	5.5
21	21	19	19.5	15	11	18	18	17.5	20	21	19
Correlation		.26	.68	.04	.56	.20	.33	.24	.28	.32	.49
$P.E._r$		±.14	±.08	±.15	±.11	±.15	±.14	±.14	±.14	±.14	±.13

The average learning, memory test, and relearning scores for the upper, middle, and lower thirds of the group are given in Table LIX. The lower group required 3.3 more trials to learn the poetry than did the upper group and 2.4 more than did the middle third. On the first memory test the upper and middle thirds recalled 33.9 words each, while the lower third recalled only 22.4 words. On the other memory tests there was not much difference in the amount recalled by the three groups.

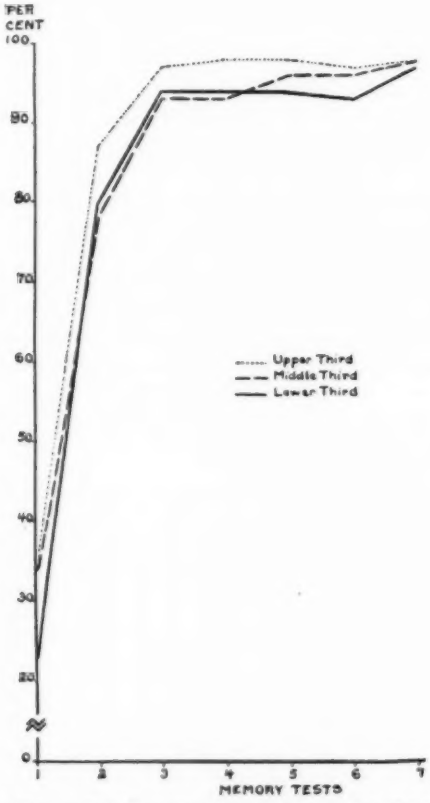

Fig. 54. Average Memory Test Percentage Scores Made by Each Third of the Group on the Stanza of Poetry in Overlearning.

The efficiency of recall for each of the three groups is clearly shown in Figure 54, which is based on percentages. The curves for the upper and middle groups are equal to or above those for the middle and lower groups on all memory tests. The distance between the curves is so slight, however, that it seems reasonable to conclude that the group of slow learners tend to be as efficient in recall as the group of fast

learners. On the first and third relearnings the lower group required more trials than did the upper or middle group, but on the second relearning the average number of trials required by each group was the same.

These data indicate that there is little positive relation between the speed of learning the stanza of poetry and the ability to recall and relearn it later.

TABLE LIX. AVERAGE LEARNING, MEMORY TEST, AND RELEARNING SCORES MADE BY EACH THIRD OF THE GROUP ON THE STANZA OF POETRY IN OVERLEARNING

Subject	Learning trial	First memory test	First relearning trial	Second memory test	Second relearning trial	Third memory test	Fourth memory test	Fifth memory test	Sixth memory test	Seventh memory test	Third relearning trial
Upper third	8.4	33.9	2.6	87.7	2.0	95.9	96.9	96.9	96.3	96.7	0.6
Middle third	9.3	33.9	2.9	78.0	2.0	92.1	91.7	94.9	95.4	96.7	0.9
Lower third	11.7	22.4	4.1	79.7	2.0	92.7	92.7	93.1	92.6	96.1	1.0

Conclusions. The important results of the study of the relation of retention to speed of learning in overlearning are:

1. No significant positive relation was found between retention and speed of learning.
2. Practically all of the correlation coefficients between speed of learning and memory test scores and speed of relearning are positive, but the correlations as a whole are too low to be highly significant. The correlations between speed of learning, memory test scores, and speed of relearning are given in Table LX.

   Conclusions based on these correlations may be criticized, however, because of (1) the simplicity of the learning material, (2) the homogeneity of the learning ability of the subjects, and (3) the large number of tied ranks.

TABLE LX. CORRELATIONS OF SPEED OF LEARNING WITH MEMORY TESTS AND SPEED OF RELEARNING IN OVERLEARNING

Test material	First memory test		First relearning trial		Second memory test		Second relearning trial		Third memory test		Fourth memory test		Fifth memory test		Sixth memory test		Seventh memory test		Third relearning trial	
	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r	r	PE_r
Nonsense syllables	.10	.15	.36	.13	.20	.15	.44	.13	.29	.14	.13	.15	.02	.15	.10	.15	.04	.15	.19	.15
Words	-.02	.15	.37	.13	.39	.13	.37	.13	.44	.12	.32	.14	.35	.14	.51	.11	.42	.13	.45	.12
Names and dates	.34	.13	.20	.14	.08	.15	.50	.11	.44	.12	.44	.12	.29	.14	.21	.15	.17	.15	.02	.15
Geometric figures	-.20	.15	.41	.13	.10	.15	.53	.11	.01	.15	.31	.14	.43	.13	.28	.14	.19	.15	.22	.14
Symbols	-.21	.15	.24	.14	.13	.15	.54	.11	.09	.15	.21	.14	.07	.15	.05	.15	.18	.15	.02	.15
Poetry	.26	.14	.68	.08	.04	.15	.56	.11	.29	.15	.33	.14	.24	.14	.28	.14	.32	.14	.49	.13

3. When the average number of trials required to relearn are compared with the average number of learning trials for each group, there is little evidence that the group of subjects who learned fastest relearned with significantly fewer trials than the group of average or

slow learners. If, however, the comparisons are based on the number of trials saved in relearning, the lower third saved more trials in relearning than did the upper or middle third. The average number of learning and relearning trials and the average number of trials saved for each relearning for the three groups for each type of learning material are given in Table LXI.

TABLE LXI. AVERAGE LEARNING AND RELEARNING SCORES AND DIFFERENCE BETWEEN THESE SCORES MADE BY EACH THIRD OF THE GROUP IN OVERLEARNING

	Learning	First relearning	Difference	Second relearning	Difference	Third relearning	Difference
NONSENSE SYLLABLES—							
Upper	4.9	3.0	1.9	2.3	2.6	1.3	3.6
Middle	5.4	3.0	2.4	2.1	3.3	1.1	4.3
Lower	7.6	3.9	3.7	2.7	4.9	1.0	6.6
WORDS—							
Upper	5.6	2.3	2.3	2.1	3.5	0.3	5.3
Middle	6.9	3.7	3.2	2.6	4.3	1.0	5.9
Lower	8.7	4.4	4.3	2.3	6.4	0.6	8.1
NAMES AND DATES—							
Upper	6.0	2.9	3.1	2.0	4.0	0.9	5.1
Middle	7.7	3.4	4.3	2.6	5.1	0.1	7.6
Lower	10.6	3.7	6.9	2.4	8.2	0.4	10.2
GEOMETRIC FIGURES—							
Upper	6.6	2.3	4.3	2.0	4.6	0.3	6.3
Middle	7.6	2.0	5.6	2.0	5.6	0.4	7.2
Lower	8.7	2.1	6.6	2.1	6.6	0.4	8.3
SYMBOLS—							
Upper	8.9	2.4	6.5	2.0	6.9	1.6	7.3
Middle	9.9	2.1	7.8	2.1	7.8	1.0	8.9
Lower	13.4	2.4	11.0	2.1	11.3	1.3	12.1
POETRY—							
Upper	8.4	2.6	5.8	2.0	6.4	0.6	7.8
Middle	9.3	2.9	6.4	2.0	7.3	0.9	8.4
Lower	11.7	4.1	7.6	2.0	9.7	1.0	10.7

Conclusions based on the differences between number of trials required to learn and relearn may be criticized because (1) the upper group had less to relearn; (2) the reduction of one trial in relearning, when many trials were required to learn, is probably not directly comparable to a reduction in one relearning trial when few were required to learn; (3) the amount to be learned was limited, and therefore continued relearning would eventually equalize the number of relearning trials for the three groups; and (4) since the subjects were divided into three groups that were as nearly equal in number as possible, there were cases in which students of the same rank fell in different thirds of the group.

GENERAL SUMMARY

An evaluation of all the data concerning the relation of retention to speed of learning indicates that retention is not a function of the speed of learning. The results of this study show, however, that the relation between retention and speed of learning, although not large, is uniformly positive. This indicates that, when efficiency of recall and relearning are compared with speed of learning, there is more likelihood that those who learn rapidly will also retain efficiently and relearn rapidly than that a negative relation will be found.

We have repeatedly pointed out, however, that changes in the degree of relation between retention and speed of learning may result from (1)

TABLE LXII. RANKS OF EACH SUBJECT IN THE SPEED OF LEARNING EACH OF THE SIX TYPES OF LEARNING MATERIALS IN PARTIAL, COMPLETE, AND OVERLEARNING

Subject	Nonsense syllables			Words			Names and dates			Geometric figures			Symbols			Poetry		
	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning
1	1	1.5	1	15.5	5.5	2	1	2	4	4	7	7	1	4	1	7.5	5	2.5
2	2.5	1.5	6.5	4	17.5	2	8	5	1	7	13.5	14	9	1	11.5	4	1.5	2.5
3	2.5	10	6.5	7	5.5	11.5	8	5	4	1	3	2	3.5	2	5	1	1.5	8.5
4	5.5	17	20	8.5	14.5	16.5	18.5	13.5	12	13	13.5	19	13.5	7	15.5	6	15.5	14
5	5.5	15	6.5	8.5	5.5	6	4.5	9	8	7	18.5	14	11	14	11.5	7.5	10.5	8.5
6	5.5	18.5	6.5	6	..	11.5	18.5	9	19	20.5	20	7	18	10	17	3	5	2.5
7	5.5	4.5	6.5	4	5.5	6	4.5	2	8	13	21.5	14	17	10	15.5	14	21	18.5
8	11	4.5	6.5	1.5	5.5	11.5	13	..	4	7	9	2	2	10	5	2	5	2.5
9	11	..	15	10	17.5	16.5	15	13.5	8	13	7	21	13.5	14	19	5	5	8.5
10	11	4.5	6.5	1.5	1.5	2	2	9	4	7	3	14	5	7	5	12	10.5	14
11	11	4.5	15	12.5	14.5	19.5	18.5	18	12	2.5	3	2	3.5	4	5	10	10.5	8.5
12	11	10	6.5	4	5.5	11.5	18.5	13.5	4	13	13.5	14	9	17.5	19	13	15.5	14
13	11	15	15	15.5	14.5	11.5	8	9	12	17.5	21.5	14	15	17.5	19	15	15.5	8.5
14	11	10	6.5	19	10.5	6	3	..	15.5	13	7	7	16	4	5	19	10.5	8.5
15	15	10	15	11	10.5	6	14	13.5	17	17.5	3	7	9	14	5	11	15.5	8.5
16	16	10	15	15.5	10.5	16.5	12	9	12	7	3	14	7	7	11.5	17	5	16
17	17.5	..	15	21	..	11.5	22	0	19	13	18.5	19	20	14	11.5	20	18.5	18.5
18	17.5	10	15	15.5	10.5	6	10.5	16.5	15.5	19	13.5	7	12	14	5	16	18.5	18.5
19	19.5	15	6.5	12.5	..	16.5	6	16.5	12	2.5	13.5	7	6	20	11.5	9	10.5	8.5
20	19.5	18.5	19	18	..	19.5	16	..	19	13	13.5	19	19	20	11.5	18	10.5	18.5
21	21	20	21	20	..	21	21	..	21	20.5	13.5	7	21	20	21	21	20	21
22	..	10	..	..	..	..	10.5	5	..	..	13.5	..	..	..	..	..	..	..
23	..	..	..	..	1.5	..	..	2	..	..	..	..	..	..	..	..	..	..
24	..	..	..	..	14.5	..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE LXIII. RANKS OF EACH SUBJECT IN THE TOTAL MEMORY SCORES MADE IN EACH OF THE SIX TYPES OF LEARNING MATERIALS IN PARTIAL, COMPLETE, AND OVERLEARNING

Subject	Nonsense syllables			Words			Names and dates			Geometric figures			Symbols			Poetry		
	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning
1	2	1.5	5	5	10	8	1	1	7	2	10.5	2.5	1	2	2	8.5	4	7
2	5	9.5	11.5	1	14	5	10	8.5	2	11.5	3.5	12	11	6	3	14	9	2
3	7.5	11.5	13	2	15	19	11	16	14	3	12	16	7	4	15	2	12	8
4	19.5	4	7	17	1	13	19	7	17	20.5	13.5	16	18	11	17	3	3	10
5	12.5	19	6	14	8	9.5	12	14	16	7.5	1	2.5	16	7	14	19	20	6
6	12.5	17.5	14.5	19	..	18	21	12	20	16	10.5	20.5	20	16	12	4	11	9
7	9	8	20	16	3	9.5	2	5	1	11.5	22	16	13	19	20	20	21	21
8	18	20	21	12	16.5	20	16	..	19	17	19	20.5	19	17.5	19	8.5	17	14
9	15.5	..	11.5	14	13	17	14	17	10.5	9	13.5	9	14	13	13	15	16	13
10	4	6	3	3	2	3	4	4	4.5	7.5	17.5	19	4	15	10	16	7	17
11	3	16	19	18	18	13	22	18	18	6	7	6	10	17.5	16	5	15	18
12	7.5	5	8	4	11	15	18	10.5	15	5	15	10	9	8	7.5	7	2	5
13	1	7	4	11	9	11	5	13	12	18.5	5	18	6	5	1	10	18	11
14	6	9.5	16.5	20.5	16.5	16	13	..	8.5	14	7	12	17	10	21	17	13	20
15	19.5	13	1	9	6	7	3	16.5	4.5	20.5	20.5	6	8	9	4	1	1	1
16	14	17.5	10	10	7	4	7	8.5	8.5	4	3.5	2.5	2	14	9	12	8	16
17	15.5	..	18	14	..	13	20	..	13	13	20.5	6	12	12	6	13	14	15
18	10	1.5	2	7.5	5	1.5	6	2	4.5	18.5	7	14	5	1	5	11	5	3
19	11	3	9	6	..	1.5	8	3	4.5	1	2	2.5	3	3	7.5	6	10	4
20	17	11.5	16.5	7.5	..	6	17	..	10.5	10	17.5	8	15	21	11	21	6	12
21	21	14	14.5	20.5	..	21	15	..	21	15	16	12	21	20	18	18	19	19
22	..	15	..	..	..	..	9	15	..	..	9	..	..	..	..	..	..	..
23	..	..	..	..	4	..	..	6	..	..	..	..	..	..	..	..	..	..
24	..	..	..	..	12	..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE LXIV. RANKS OF EACH SUBJECT IN THE SPEED OF RELEARNING EACH OF THE SIX TYPES OF LEARNING MATERIALS IN PARTIAL, COMPLETE, AND OVERLEARNING

Subject	Nonsense syllables			Words			Names and dates			Geometric figures			Symbols			Poetry		
	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning	Partial learning	Complete learning	Over-learning
1	2	2	2	1	8.5	2	1	8	2.5	3	12.5	6	6	2	1	15	7.5	2
2	4	10	13.5	6	11	6	7	3.5	15	7	4.5	6	6	12	6	5	3	7
3	11	10	8.5	2	11	16	6	13.5	9.5	3	16.5	6	1.5	8	13.5	2	7.5	2
4	14.5	1	4.5	15.5	4.5	17.5	18.5	3.5	16	14.5	4.5	6	14	19.5	6	4	1	13
5	2	15.5	4.5	15.5	4.5	11	8	13.5	9.5	14.5	1	6	13	8	6	12.5	14	7
6	11	13	17	9.5	..	19.5	21	8	17.5	21	8.5	20.5	17	21	6	1	14	13
7	6.5	17.5	13.5	7.5	1	6	2.5	3.5	9.5	17.5	12.5	6	17	16	19	20	21	21
8	6.5	13	19	4	17	18	12	..	9.5	20	19.5	15.5	15	16	19	6	17	13
9	11	..	17	7.5	8.5	14.5	16	17.5	17.5	14.5	4.5	15.5	11.5	12	19	11	20	13
10	11	10	8.5	4	4.5	6	2.5	13.5	9.5	7	21	15.5	8	8	19	12.5	7.5	17.5
11	6.5	6	13.5	21	14.5	2	20	13.5	19	3	8.5	15.5	1.5	8	13.5	10	7.5	13
12	11	6	8.5	11	14.5	14.5	14.5	8	20	7	12.5	15.5	4	8	6	9	7.5	7
13	2	6	2	20	11	11	9	17.5	9.5	10.5	4.5	15.5	11.5	4.5	13.5	15	14	7
14	14.5	13	13.5	18.5	18	17	10	..	9.5	19	12.5	6	20	16	19	17.5	7.5	17.5
15	17	19	8.5	18.5	4.5	11	12	8	2.5	14.5	18	6	9	16	6	3	2	2
16	17	17.5	8.5	12.5	4.5	11	4.5	3.5	9.5	3	12.5	15.5	3	4.5	6	7	7.5	7
17	20	..	17	12.5	..	6	22	..	9.5	10.5	19.5	6	17	12	13.5	19	14	17.5
18	17	6	2	9.5	14.5	2	4.5	13.5	2.5	10.5	4.5	20.5	10	2	6	8	14	7
19	6.5	3	8.5	4	..	6	17	1	2.5	3	4.5	6	6	2	13.5	21	7.5	7
20	19	15.5	21	15.5	..	11	14.5	..	9.5	10.5	22	15.5	19	16	6	17.5	18.5	17.5
21	21	20	20	15.5	..	21	18.5	..	21	17.5	16.5	6	21	19.5	13.5	15	18.5	20
22	..	6	..	..	..	..	12	13.5	..	..	12.5	..	..	..	..	..	..	..
23	..	..	..	..	4.5	..	..	8	..	..	..	..	..	..	..	..	..	..
24	..	..	..	..	14.5	..	..	..	..	..	..	..	..	..	..	..	..	..

the degree of learning, (2) the type of learning material, and (3) the method of treating the data. Variations resulting from these factors seem to be further evidence that retention is not a function of speed of learning.

The voluminousness of the data precludes the inclusion of many interesting aspects of the study which, if space had permitted, would have been given to show that retention was more closely related to other aspects of learning than to speed. For example, a careful analysis was made of the reproductions following each learning trial in order to determine the methods of learning. This analysis indicated that those who learned rapidly had more efficient methods of organizing the material into stable and meaningful patterns. The use of better learning methods is the more likely reason for the closer relation between retention and speed of learning in partial learning. The rapid learners were efficient learners and enough of the material was learned for it to be organized into stable patterns. When the relation between retention and speed of learning was compared for the three degrees of learning, it was found to be uniformly higher for partial learning than for complete and overlearning. There was no significant difference between complete and overlearning. Slow learners, when given unlimited time to learn, seem to build up just as stable patterns of the material as do the rapid learners.

Further evidence that factors other than speed of learning are dominant in efficiency of retention is found in a comparison of the individual's speed of learning in the different types of learning materials for the three degrees of learning. These data are given in Table LXII. The rank for speed of learning for each subject is given. When read from left to right, these data show that there are marked variations in the speed of learning the different materials. There is, however, a tendency for the individual to maintain a relatively constant position on each type of material in the three degrees of learning. When compared with the total ranks on the memory test scores given in Table LXIII, these data show that efficiency of recall as it relates to individual performance is positively related to speed of learning. The significance of the relation is largely lost when the group as a whole is studied.

The data in Tables LXII, LXIII, and LXIV show that there is a positive relation between the ranks of each individual on the three degrees of learning. However, the significance of the relation is largely lost when the group as a whole is studied.

The more carefully the results of this study are analyzed the more apparent is the tendency for the relation between retention and speed of learning to be an individual phenomenon. Since it is an individual phenomenon rather than a group phenomenon, it would seem advisable from the educational point of view not to attempt to predict the efficiency of retention as measured by recall and relearning from a knowledge of the speed by which the material was learned.

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A List of Bulletins in the Field of Education, Indiana University

The following is a list of the bulletins published by the School of Education, Indiana University.

All bulletins which are available at the present time may be secured for fifty cents ($.50) per copy, with the exception of the *Second Revision of the Bibliography of Educational Measurements;* the *Bibliography of School Buildings, Grounds and Equipment—Part I; The Philosophy of Human Relations—Individual and Collective;* the *Bibliography of School Surveys and of References on School Surveys;* and the *Bibliography of College and University Buildings, Grounds, and Equipment,* which may be secured for seventy-five cents ($.75) per copy and may be obtained from the University Bookstore.

Proceedings of the High School Principals' Conference (November 23 and 24, 1923). Vol. I, No. 1, 1924. 85 p. (Supply exhausted.)

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Proceedings of the Eleventh Conference on Educational Measurements. Vol. I, No. 3, 1925. 141 p.

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First Revision of the Bibliography of Educational Measurements. Compiled by the Bureau of Coöperative Research. Vol. I, No. 5, 1925. 147 p. (Supply exhausted.)

Proceedings of the Twelfth Conference on Educational Measurements. Vol. I, No. 6, 1925. 76 p.

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An Analysis of the Attitudes of American Educators and Others Toward a Program of Education for World Friendship and Understanding. By Henry Lester Smith and Leo Martin Chamberlain. Vol. V, No. 4, 1929. 109 p.

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